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THE EFFECTS OF INTERACTION BETWEEN GENOTYPES ON SINGLE PLANT
SELECTION OF WHEAT (*TRITICUM AESTIVUM*)

by

HENRIETTE A. KELKER



A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
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IN
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Abstract

In the first year of the study, the response of wheat plants to genotype interaction was studied on monocultures and mixtures of seven wheat genotypes, at seven different interplant spacings. The genotypes differed significantly in their response to genotype interaction.

In the second year, mixtures and monocultures of five genotypes were grown at two different interplant spacings. The mean variation of the number of tillers, plant weight and yield of the genotypes grown in mixtures at the closer spacing, and of kernel weight at the wider spacing, differed significantly from the mean variation in monoculture. For the plants grown in mixtures, an increase in spacing was accompanied by an increase in the plant to plant variation of the number of tillers, the number of heads, plant weight, yield, kernels per plant, kernel weight and harvest index. Similar effects were observed for plants grown in monocultures.

With the exception of height of the flag leaf, plant height and harvest index, the effect of genotype interaction on plant characters differed significantly among genotypes. Correlations between pairs of characters, measured on genotypes and their associates, revealed that the characters which affect (or respond to) genotype interaction are not the same at different spacings and in different genotypes.

In the third year, the effect of initial seed size on plant interactions in five monocultures was examined. Number

of tillers, number of heads, and kernel weight were affected by initial seed size in plots from uniform seed. Plants from large seeds produced more tillers than did plants from small seeds, but plants from small seed produced larger kernels than did plants from large seeds. In plots from mixed seed sizes, however, neighbor interaction caused plants from small seeds to produce shorter plants, bearing lighter seeds, than did plants from large seed.

The data demonstrated that the distribution of many characters, in monoculture as well as in mixture, is not normal. It was shown that, if one selects the highest values for a character, characters which have a negatively skewed distribution are selected with less error than are characters for which the distribution is normal or positively skewed.

Yield trials of mixtures and monocultures were repeated for three years. Only in 1977 did the mixtures yield significantly more than the mean of the monocultures of the components. Interactions between the genotypes differed from year to year.

It was concluded, that the efficiency of selection of single plants from a segregating population is affected by variation due to different initial seed sizes, variation due to interaction between plants from different size seeds, and variation due to interaction between different genotypes, as well as by the frequency distribution of the observed characters.

It was recommended that, in order to evaluate the suitability of a character for selection in early generations, the distribution of this character in a multi-component mixture, as well as its sensitivity to genotype interaction, should be evaluated in conjunction with the estimation of its heritability.

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1. Introduction

In the history of wheat cultivation, the use of homogeneous cultivars is relatively new. Cultivated wheat populations used to be, and in some countries still are, composed of a large number of genotypes. For centuries, selection was practised by farmers for the plant types best suited for their needs. This resulted in plant types with large free threshing seeds, and increased yields, with better flour quality and with adaptation to a wide range of climatic conditions (Feldman, 1974). Although the principles of selection have been practiced in a more methodical way since the second half of the 18th century (Darwin, 1859), plant breeding has been recognised as a science only since the last part of the 19th century (Allard, 1960).

Almost all current selection methods for small cereals are based on line selection and its modifications (Sneep et al., 1979). These involve the selection of single plants or progeny rows in the early segregating generations.

It is widely recognised that single plant selection for quantitative characters, such as seed yield, in the segregating generations of a breeding program, is largely ineffective. Several studies have attempted to associate various plant characters in the F₂ or F₃ generations, with the expression of characters in more advanced generations (McGinnis and Shebeski, 1968; Hamblin and Donald, 1974). Interaction between genotypes is considered to be an important cause of the phenotypic variation which hinders



single plant selection (Kiesselbach, 1923; Christian and Gray, 1941). Yet, the effects of specific characters of one plant on the phenotype of its associates, and the implications of these effects for single plant selection, are unclear.

The present study focuses on the interactions between genotypes of common spring wheat (*Triticum aestivum* L.). The study was undertaken to determine the responsiveness of specific plant characters to the presence of other genotypes, and to evaluate the factors associated with the ability to perform well in a mixture situation. The results are discussed in relation to current plant breeding practices.

2. Literature Review

2.1 Terminology

Plant interactions have been studied by scientists from various branches of science, and each discipline has its own definitions and nomenclature. In 'The Origin of Species', Darwin (1859) discussed the competition which takes place between individuals within both the plant and the animal kingdoms. He preferred to use the term 'struggle for existence'. The term 'competition' was used by Odum (1971), who stated that competition, in the broadest sense, refers to the interaction of two organisms striving for the same thing. Harper (1961) described the different approaches of agronomists, ecologists and geneticists to plant competition. From an agronomist's point of view, competition is 'the response of plants to density-induced shortages'. The ecologist considers competition as 'all those forces by which one organism succeeds at the expense of another', while the geneticist deals with the 'effect of interaction operating between individuals of different genotypes within a population'.

A frequently quoted definition of competition was given by Clements et al. (1929), and reads as follows:

'Competition arises from the reaction of one plant upon the physical factors about it and the effect of the modified factors upon its competitors. In the exact sense, two plants

do not compete with each other as long as the water content, the nutrient material, the light and the heat are in excess of the needs of both. When the immediate supply of a single necessary factor falls below the combined demands of the plants competition begins.'

Because the word competition is commonly associated with negative effects, its use has been avoided by several authors. Harper (1961) preferred the term 'interference', while Trenbath (1974, 1975) and Trenbath and Harper (1973) used the term 'neighbour effects'. Mather (1961) distinguished 'competition' from 'cooperation', and pointed out that individuals which are competing in one respect may be cooperating in another.

Hall (1974) attributed the responses of plants to their neighbours to both competitive and non-competitive interference. Competitive interference, as defined by Hall, is the same as competition for essential growth factors, as defined by Clements et al. (1929). Non-competitive interference occurs when an individual responds to changes in its environment, which are caused by other plants and which do not fall into the first category. As an example of non-competitive interference, Hall named the positive effect which a legume can have on the growth of a non-legume. This happens when nitrogen, fixed by the legume, becomes available to the non-legume through mineralisation (Henzell and Vallis, 1977).

The word 'interference' implies a one-way process. The mutual influences of plants upon each other can therefore perhaps be best described by the word 'interaction'. The effects of interaction between genotypes are measured as the phenotypic deviations of plants grown in mixed culture from those grown in pure culture, under otherwise similar growing conditions.

2.2 Mixtures vs. monocultures

The literature on mixtures of crop cultivars goes back at least as far as the last part of the 19th century, and the value and practicality of mixtures as a crop has been a much disputed issue. Von Rümker (1892) reviewed several of the older European studies and advocated the use of mixtures in an effort to increase the yield per unit area, especially where it concerned grains used for animal feed.

Montgomery (1912) concluded that, on the average, both oats and winter wheat had higher grain yields when grown in cultivar mixtures than when grown alone. Unfortunately he examined only two cultivars of each species in this study. Similar observations were made on wheat by Engelke (1935), who also noted that total tiller density was always higher in mixtures than in monocultures.

Data on a mixture diallel of four wheat cultivars (Nuding, 1936) were reanalysed by Simmonds (1962). He subsequently showed that the mean yield of the components in

monoculture was negatively correlated with their performance in mixture. The yields of the six mixtures all exceeded the mean yield of their component monocultures, and the highest yields were obtained from mixtures of genotypes which were known to have a wide range of adaptation.

In contrast to the above reports, Heuser (1938) concluded from the trials of five wheat cultivars and their binary mixtures, that monocultures yield at least as well as, and sometimes better than, mixtures do.

Three genotypes of wheat, which were similar in morphological characters, development and yield, produced yields in mixture which were similar to their yield in monoculture (Frankel, 1939). The similarity of the genotypes in this study might explain the lack of effect from genotype interaction.

A review of the more recent literature on the performance of mixtures of genotypes and mixtures of species was made by Trenbath (1974). The reviewed studies examined the biomass production of several forage, cereal and oil seed species. In 344 two-component mixtures, 60% of the mixtures - which is significantly ($\alpha \leq 0.01$) more than half - yielded more than the mean of the component monocultures, while 24% yielded more than the higher yielding monoculture. This suggests that, on the average, biomass production per plant is better in mixtures than in monocultures.

After evaluating a number of different types of rice (*Oryza sp. L.*) mixtures, mixing techniques and cultural

practices, Roy (1960) concluded that the chances for gaining or for losing yield potential through the formation of mixtures are about equal and that most advantages of mixtures are obtained when the soil conditions are poor. An advantage of mixtures over monocultures under extreme environmental conditions was also observed for barley (*Hordeum vulgare* L.) grain yield (Clay and Allard, 1969), in a study involving twentythree mixtures, evaluated over two years and five locations.

The performance of a mixture of two wheat cultivars (Pitic 62 and Neepawa), sown at various seeding rates differed in the two years of the study (Baker, 1977). This was ascribed to the fact that Pitic 62 was better able to compensate for poor survival after early drought conditions, when grown in pure stand, than when grown in mixture. The reason for this different ability to recover was not discussed, however. Further study of this observation could clarify the process of interaction which takes place between these two wheat genotypes.

Simmonds (1962) wrote an extensive review on the variation in crop plants, and indicated that mixtures, besides being often slightly superior in yield, are usually also more reliable in their performance, especially under conditions of stress.

It thus appears that in the majority of cases, stress conditions affect mixtures less than they do monocultures. With this in mind, it is interesting to note that in a study

by Shorter and Frey (1979), which was conducted over two years and at two locations, the genotype x year, the genotype x location, and the genotype x year x location interactions were insignificant most of the time (12 out of 16) for mixtures, and were always significant for monocultures.

For lima beans (*Phaseolus lunatus* L.), it was observed that the stability of performance is related to the degree of genetic variation in the population. Allard (1961) studied the performance of ten lima bean populations: three monocultures, three two-component mixtures, one three-component mixture and the advanced generations (F7 and F9) from crosses between these three genotypes. He found that, although the monocultures performed most often either very poorly or very well, the mixtures consistently performed at a mediocre level, while the bulk populations performed well most of the time. He concluded that the genetic diversity of the mixed and bulk populations apparently made them more stable.

The yield of five two- and three-way mixtures of barley genotypes appeared to be more stable over years and locations than were the yields of the component genotypes grown in monoculture (Early and Qualset, 1971). At the same time, a tendency was observed for the plant-to-plant variation within a genotype to be greater in mixtures than in monocultures. This is perhaps not surprising, since the micro-environment within the crop stand also is more

variable in a mixture of plant types than in a monoculture.

The reviewed studies suggest that mixtures often perform in a more stable manner than do monocultures. In order to evaluate the relative performance of mixtures and monocultures, it is therefore advisable to repeat any study of competition effects for a number of years. Close observation of single plant characters under both mixture and monoculture conditions during these years could reveal the mechanism underlying the stability of mixtures, and could possibly explain why certain genotypes are better combiners in a mixture

2.3 Types of interaction and interaction effects

Interactions between plants occur in monoculture as well as in mixed populations. Since developmental patterns of genotypes within a species can differ considerably, interplant relations within a mixture of genotypes will differ from those in monoculture. Interaction between plants of two different species or two genotypes of the same species can be detrimental, neutral or beneficial to either or both associates. Depending on the degree of interaction and the proportion in which each component occurs in the mixture, the mixture yields can be less than, equal to, or more than what can be expected from the monocultures of each component.

Since interactions vary with the growth stage of each of the plants involved, variation in the relationships between the individuals of a population can be brought about by varying the relative growth stages of the interacting plants. This can be achieved through variations in the time of emergence (Ross and Harper, 1972), variations in the seeding depth (Black, 1956), or variations in seed size of the population members (Montgomery, 1912; Kaufmann and McFadden, 1960). Interactions between components of a mixture can also be varied through variations in density (Kira et al., 1953; Chebib et al., 1973) or variations in the proportions of the mixture components (de Wit, 1960; Hill, 1974).

The effect on mixture yield of varying proportions of mixture components at a constant overall density has been studied by de Wit (1960) and by Hill (1974). De Wit introduced the term 'replacement series' for experiments, in which the performance of monocultures and mixtures containing a range of different proportions of two types of plants are assessed.

In de Wit's experiments, population pressure was maintained at a constant level by using optimal seeding rates appropriate for each of the components. Thus, in an experiment involving various proportions of oats and peas, oats were given 31 cm²/kernel and peas were given 139 cm²/kernel in all plots (de Wit, 1961).

De Wit's model assumes that the genotypes in a mixture exclude each other and crowd for the same 'space'. Space is assumed to be uniformly distributed and encompasses all essential growth factors. De Wit considered it undesirable to define these factors, since: 'such a description is not necessary, always inaccurate and therefore inadvisable.' (de Wit, 1960). Hall (1974) explained, however, that identification of a particular limiting factor could give valuable insight into the interaction process.

A replacement diagram consists of curves which represent the measurements on yield or other characters for each mixture component, obtained from a series of mixtures of different proportions, as well as a curve representing the sum of the component yields (total mixture yield) for each mixture. These diagrams can take on any of the basic shapes given in the figures 1a to 1d, and can be explained as follows, using plot yield as an example:

1. Interaction between genotypes has no effect on the yield of either one of the mixture components (Figure 1a).
2. Interaction between genotypes decreases the yield of genotype A, while it increases the yield of B (Figure 1b). The combined effects, however, cause no change in the total yield of the mixture. One can speak in this case of 'complementary competition' (Shuts et al., 1968).
3. Interaction between genotypes decreases the yields of both A and B (Figure 1c). This can result in a total

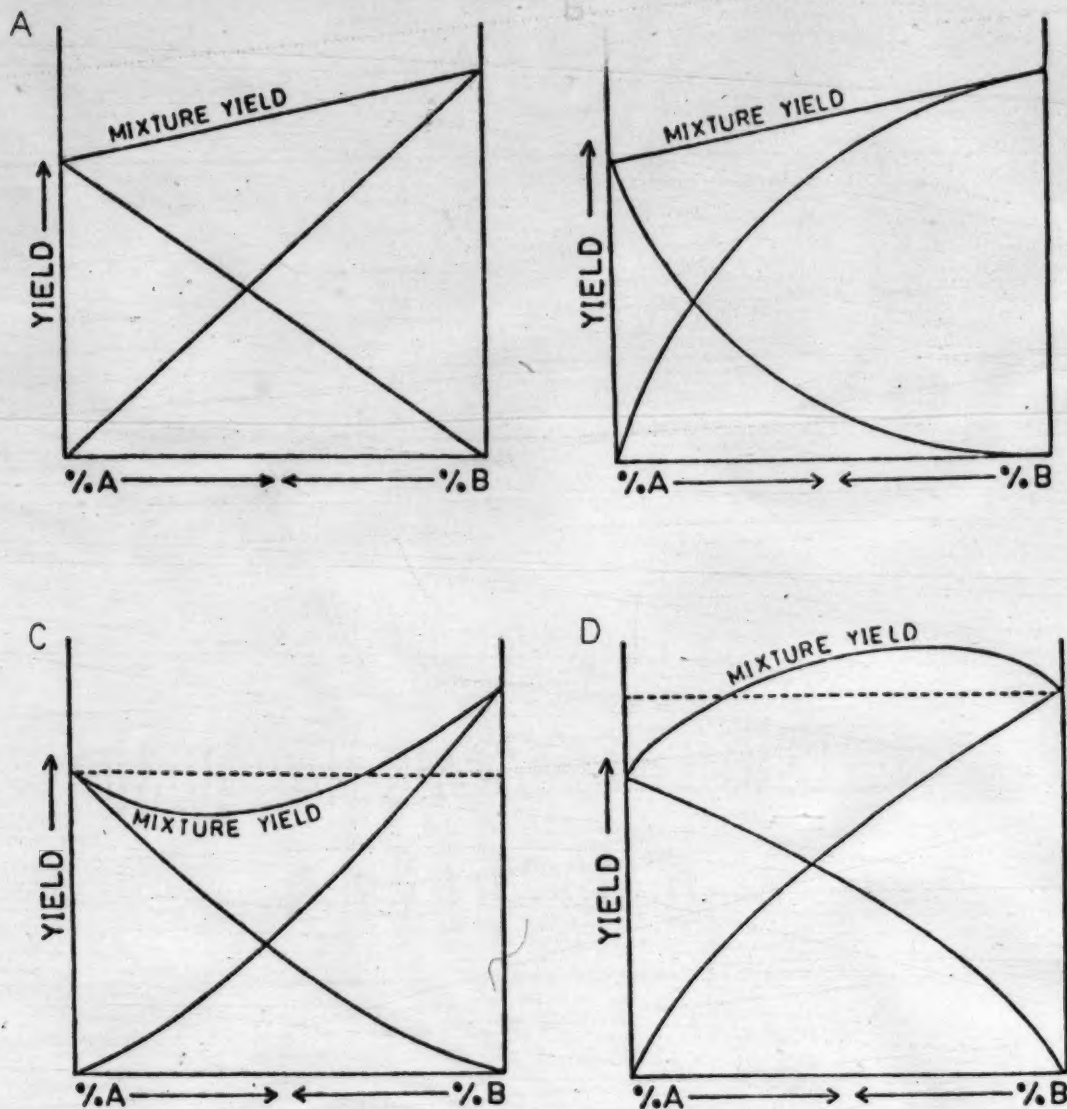


Fig. 1a-d Graphic illustration of four possible types of genotype interaction effects on genotype and mixture yield of two genotypes, A and B, grown in binary mixtures of varying proportions ('Replacement Series').

%A and %B in the mixture are marked along the X-axis, reading from left to right for genotype A, and from right to left for genotype B.

mixture yield intermediate between the yields of A and B grown in monoculture (section 'p') or in a total mixture yield which is less than the monoculture yield of the lower yielding genotype (section 'q'). In the latter case one can speak of 'underyielding' of the mixture (Trenbath, 1974).

4. Interaction between genotypes increases the yields of both A and B (Figure 1d), resulting in a total mixture yield which is lower than the yield of the better monoculture, but higher than the yield of the poorer monoculture (section 'p'), or in the mixture yield being higher than the yield of the better monoculture (section 'q'). In the latter case one can speak of 'overyielding' of the mixture (Trenbath, 1974).

An understanding of the mechanisms leading to overyielding could be exploited to increase yield. In general, overyielding occurs in mixtures of species which exhibit marked differences in their pattern of growth. These differences provide the potential to utilise the available resources more efficiently (de Wit, 1961; Trenbath, 1974; Clark, 1980). In herbage plants, Hill (1974) demonstrated that a 50:50 mixture is not usually the optimal composition to maximise forage yield. This conclusion agrees with the diagram in Figure 1d, which shows that overyielding is more likely to occur in mixtures containing a higher proportion of the better yielding genotype.

Differences between genotypes of cultivated cereals are probably more subtle than are those between the components of a mixture of species, because plants of the same species are more similar in growth habit and nutrient requirements. Nevertheless, the presence of genetic differences implies the existence of differences in the various aspects of plant growth. Thus, the potential exists for complicated interplant relationships, which are different from those occurring in a monoculture.

A great number of factors play a role in plant interactions. There is therefore little hope that a generalised set of rules can be designed from which the outcome of plant interactions can be accurately predicted. Hill (1974) recognised this when he presented a theoretical model for the prediction of the value of binary mixtures of herbage species. He emphasised that plant interaction is a dynamic phenomenon, and that relationships can be transient.

2.4 Effects of plant interaction on plant growth

2.4.1 Plasticity of plant characters

The ability of plant parts and processes to respond to variations in the environment has been extensively discussed by Bradshaw (1964). He presented evidence that the plasticity of a certain character

- a. is specific for that character,

- b. is specific in relation to particular environmental influences,
- c. is specific in direction,
- d. is under genetic control, not necessarily related to heterozygosity, and
- e. can be radically altered by selection.

His theories on the role of plasticity of plant characters in evolution and adaptation apply directly to the interpretation of interactions between plants of different genotype. Bradshaw proposed that the plasticity of a character is related to the duration of meristematic activity which pertains to its development. Stemplength, for example, is controlled by long periods of meristematic activity and will therefore be more susceptible to environmental influences than are characters which are formed rapidly, such as reproductive structures. However, within this framework, there exists great variation among species as well as among genotypes within species.

Bradshaw explained that as a result of natural selection, a character whose stability is important for survival will likely show greater stability than will a character for which some plasticity is not a disadvantage. Harper (1961) pointed out that seed size is often surprisingly stable, thus ensuring an equal starting capital for each seedling. Significant variations in seed size due to interaction between genotypes, however, have been reported for wheat

(Christian and Gray, 1941; Chapman et al., 1969).

For some characters, plasticity can play a great role in adaptation. Height of many species appears to be a very plastic character. Trenbath and Harper (1973) described the different abilities of several oat species (*Avena* sp. L.) to adapt to different competitive situations through changes in height. *Avena sativa* was found to be capable of a stem extension of 10 cm above its monoculture value when grown in association with the taller *A. ludoviciana*. This resulted, for *A. sativa*, in a 20% increase in kernel weight over its monoculture value. They discussed the biological significance of this 'extension response' and concluded that such a mechanism must lead to a more even sharing of radiation. In natural communities this would conserve genotypes and thus diversity.

In corn the rapid elongation rate of one plant has an accelerating effect on the elongation rate of its neighbours (Hozumi et al., 1955). This effect appeared to be transient, however, resulting in an oscillating pattern of elongation rate in each plant.

Because environmental conditions in the field vary a great deal, stability of certain characters necessarily implies plasticity in others. Plant height, for example, is in a monoculture usually very uniform. Plasticity must therefore exist in some characters which determine plant height, such as elongation rate at various stages of development. Plasticity of the components of a certain

character can result in either stability or plasticity of the resultant character. Plant weight and grain yield of cereals are not considered as stable characters, nor are most of their components. However, harvest index, which is the ratio of grain yield and plant weight, is surprisingly stable over a range of environments (Donald and Hamblin, 1976).

If the degree of plasticity of various characters is genotype specific, as suggested by Bradshaw, then this could have important implications for a genotypes ability to perform in a mixture. Sakai (1955) concluded from a study of twelve barley cultivars that this 'competitive ability' was not associated with any of the characters he measured: plant height, maturity, seed size, habit of growth (erect vs. prostrate), heading habit (spring or winter) or grain yield. He concluded that competitive ability is a biological character in its own right and is under genetic control.

This conclusion has been criticised by several authors (Donald, 1963; Harper, 1965). Harper (1965) pointed out the incompleteness of Sakai's list of characters and stressed the importance of further investigations involving characters such as depth and extent of the root system, leaf area and height of the flag leaf. Sakai's theory on competitive ability as a genetic character is in agreement, however, with Bradshaw's views (1964) on the genetic control of the plasticity of each individual character.

2.4.2 Competition for water and nutrients

Suneson (1949) described experiments involving a mixture of four similarly adapted barley cultivars. Over sixteen years, two of the four components virtually disappeared from the population, even though one of them, Vaughn, had a significantly better yield potential and resistance to leaf diseases than any of the others when grown in pure stand. Atlas, the cultivar which eventually dominated the mixture, had the poorest leaf disease record and a mean yield below the median of the component cultivars.

Subsequent attempts to analyse the relationships between Atlas and Vaughn revealed that competition for light was not a decisive factor (Edwards and Allard, 1963), but that competition was primarily for moisture and nutrients (Hartmann and Allard, 1964). Lee (1960) observed that the response to competition between the two cultivars appeared abruptly at the jointing stage, when Atlas developed a dense mass of crown roots. Since Vaughn did not develop as large a root mass, Lee suggested that Atlas would become more efficient in gathering nutrients and would have the advantage when both varieties have to draw from the same soil mass.

Competition between roots usually starts long before the shoots are sufficiently developed to cause significant mutual shading (Milthorpe, 1961). But, competition for nutrients often leads to competition for light, since an

unevenly distributed nutrient supply will result in a similar variation in shoot growth. The study of nutrient competition without consideration of competition for light is therefore possible only under conditions which artificially prevent intermingling of the leaves of neighbouring plants.

Such studies have been performed by Donald (1958) on a mixture of grasses and by Aspinall and Milthorpe (1959) on barley and white persicaria (*Polygonum lepathifolium* L.) Both studies involved mixtures of species grown in pots.

Aspinall (1960) concluded that root competition, presumably for nutrients, since water was supplied in adequate amounts, reduced growth of the less successful component more than did shoot competition. Donald emphasised the interaction which occurs between competition for light, competition for nutrients, and factors indirectly affected by the two.

Both authors mentioned differences in embryo size and in the size of the root systems of species as the main causes of competitive interference in the early stages. These same factors should then play a role in pure stands if random variation occurs in initial seed size and rate of germination.

2.4.3 Competition for light

For most crop species, photosynthetic rate in an individual leaf is saturated at 150,000 - 200,000 lux (Donald, 1961). This is well below the flux density experienced by the top layer of a canopy on a sunny day. In a closed crop stand a large part of the foliage is shaded and will receive light intensities which are below the level of light saturation, except perhaps during the midday hours on a very bright day.

Horizontal as well as vertical distribution of the leaves and leaf angle will affect the amount of light which can be intercepted and utilised by a crop. Erect leaves will allow more light to penetrate into the canopy, enabling a larger leaf area to take part in photosynthesis.

Competition for light within a canopy will not occur until the photosynthetically active radiation which reaches the surface of the leaf falls below the saturation level. With higher light intensities, competition will occur deeper inside the canopy.

Donald (1967) described the ideal wheat plant for cultivation at high densities, such as are customary for most cereals, and suggested that it should have small erect leaves. This would maximise the area which is illuminated. Nichiporovich (1967) also discussed this subject and stressed that a different leaf angle will be optimal at different latitudes or climates. According to the latter, some cereals have an arrangement of leaves in which the top

leaves are approximately vertical, the middle leaves are inclined at intermediate angles and the lower leaves are nearly horizontal. Nichiporovich considered this the ideal arrangement for plants to be grown at high densities. In a mixture of genotypes, this type of plant would also be less susceptible to shading by taller plants, than would types with more horizontal leaves.

Donald (1961) stated that competition for light takes place between leaves rather than between plants or species. This is well illustrated by the studies of Brougham (1958) on competition for light in a sward of white clover. It was shown that, following defoliation, mature petiole length of successive leaves became longer, suggesting an attempt to reach daylight through the increasingly dense canopy.

Because the growth patterns of genotypes differ from each other, the start of plant interactions and their effects on subsequent processes will be different in mixtures than in monocultures. Trenbath and Harper (1973) found that, under optimal moisture and nutrient conditions, reactions of *Avena* species to genotype interaction could be explained in terms of the shading experienced at different stages of development. Early shading appeared to have a depressive effect on tiller number, while shading of the flag leaf during grain filling had a pronounced effect on seed weight.

The effects of shading on wheat at different points in development were studied by Fischer (1975). He found that

the period of rapid spike growth was the most sensitive to shading, resulting in fewer grains per spikelet and low tiller survival.

A negative correlation between shoot elongation rate and shoot length tended to equalise the height of corn plants during the first few weeks of growth (Hozumi et al., 1955). This effect caused temporary variations in the shoot elongation rate of individual plants. Later in the season, when competition became more severe, this correlation changed into a positive one, suggesting suppression of small plants by taller neighbors.

Growth rate of the high yielding dwarf wheat cultivar Yecora was found to be sensitive to low shading intensities, of three to four weeks duration, at various times during the growing season (Fischer, 1975). Shading at any time reduced crop growth rate. The strongest reductions in yield, however, occurred when the plants were shaded during the month before anthesis. Although the shading treatments in these experiments involved complete plots, one can expect shading by taller neighbours to have similar effects.

Yoda et al. (1957) found that the growth of rose mallow (*Hibiscus moschentos* L.) seedlings, during the latter part of the growing season, was more closely related to the relative size rather than to the absolute size of neighbouring plants. They discussed Hozumi's findings as well as their own, and concluded that the change from a negative to a positive correlation between plant size and

growth rate marked the point where the growth reductions due to reduced photosynthesis surpassed the etiolating effects of competition for light. The change from a negative to a positive correlation occurred earlier in dense plantings than at wider interplant spacings, supporting this theory.

An increase in the mean plant height of a mixed wheat population was observed by Khalifa and Qualset (1975), who planted the progeny of a cross between short statured and standard height wheats, without artificial selection, for six generations. They found that the frequency of short statured plants in the population decreased, suggesting that tall plants were more successful in setting seed, in spite of a significant negative correlation between height and yield.

In a similar study Busch and Luizzi (1979) found no evidence of such a directional shift. They ascribed this lack of change to either a lesser genetic range in height in their material or to the lesser expression of height differences in the more limiting dryland environment of North Dakota, compared to that of California.

2.4.4 Effects of seed size on plant interactions

The place that an individual occupies within the hierarchy of a plant population seems to be largely determined in the very early stages of plant development (Harper, 1977). Seed size is one of the first factors affecting this early development, and it was shown by

Austenson and Walton (1970) that a two or three fold difference in weight can exist among kernels of wheat in the same head.

The effect of seed size on plant development has been quantitatively studied by various authors. Kiesselbach (1924) reviewed a number of investigations made on cereals around the turn of the century, and added to this many of his own findings. He concluded that:

1. When small and large seeds of various cereal crops were space planted, small seeds developed into considerably smaller plants than did large seeds, giving correspondingly lower yields (on the average 19% less). This result was ascribed to the differences in energy reserves of the seeds, and hence, in initial seedling vigour.
2. When equal numbers of small and large seeds were planted at a rate optimal for the large seeds, the reduction in yield of the plants from small seeds was less than the reduction at wide spacings, although the small seed plants still yielded on the average 11% less than did the plants from large seed.
3. When equal weights of the two types of seed were planted, the plants from small seeds yielded on the average 3% less than did the plants from large seeds. The greater number of small seeds planted compensated almost completely for the smaller size. When equal weights of large seeds and unselected seeds were

planted, the plants from unselected seeds consistently yielded slightly more than the plants from large seeds. Averaged over 131 test years, the advantage of unsorted seed over large seed was 2.1%. The author did not speculate on the cause of this more efficient performance of a mixture of seed sizes.

Interaction between plants from different seed size within a genotype, and between genotypes differing in growth rate, was studied by Christian and Gray (1941). In both late and early cultivars of wheat, seed size affected the number of tillers and the number of heads per plant. Differences between the genotypes in their performance in mixture affected the the number of heads per plant but not the number of tillers per plant. Thousand kernel weight of the early genotype was significantly reduced by competition from the late genotype, but the latter was not affected.

A similar study was conducted by Kaufmann and McFadden (1960). They studied the competitive interactions between barley plants grown from large and small seeds, and concluded that plants from small seed are more negatively affected by increased plant density than are plants from large seed. The main character responsible for the yield reduction in response to increased density was the number of heads per plant. They reported a ratio of yield from large and small plants of 1:0.78 at a 10 cm equidistant spacing and a ratio of 1:0.54 at a 5 cm equidistant spacing. Comparisons of yield from plots seeded to equal numbers of

either uniformly large seeds or uniformly small seeds revealed, as did the studies of Kiesselbach (1924) and Christian and Gray (1941), a higher yield for the large-seed plots.

The effects of seed size on components of yield were studied in more detail by Austenson and Walton (1970). They found that, within each of three cultivars of wheat, total yield, grain yield, straw yield, the number of heads per plant and number of seeds per plant were significantly correlated with initial seed weight. Variation in initial seed weight accounted for from 2.5 to 4.5% of the variation in these characters at maturity. Thousand kernel weight and number of seeds per head appeared to be unrelated to initial seed size.

Black (1958) demonstrated that, in two swards of subterranean clover, derived from equal numbers of seedlings but from different seed sizes, all plants in both swards eventually reached the same size. When large and small seeds were mixed, however, the plants from large seeds progressively suppressed the plants from small seeds and eventually made up 90% of the dry weight and leaf area of the sward.

Black noted that the relative growth rate of both the swards from large seeds and small seeds declined once a critical leaf area was reached. The plants from large seed reached this point faster than did the plants from small seed.

Kaufmann and McFadden (1960) reported that the vigorous growth of barley plants from large seeds resulted in an earlier development of second and subsequent leaves and of tillers than was the case for plants from small seed, but no difference was reported in the onset of flowering.

The importance of seed size and seedling growth rate to interplant relationships was demonstrated by Aspinall and Milthorpe (1959) and Aspinall (1960), who studied the interaction between barley and white persicaria. They concluded that, although in pure culture white persicaria has a faster relative growth rate than does barley, the latter has a larger embryo and initial seedling size, enabling it to establish a larger root system more rapidly and thus to gain an advantage when grown in a mixture. Restricted nutrient supply appeared to depress the growth of white persicaria more than did shading by the barley plants.

At the onset of flowering of the barley plants, when barley root growth and leaf expansion decrease, the persicaria plants immediately increased their growth rate, demonstrating the changes in interplant relations which can occur as plant development progresses.

Litav and Isti (1974a,b) compared the growth of seedlings of large and small seeded spinach (*Spinacia oleracea* L.) strains. Both strains gave the same individual plant yield in pure culture. The authors concluded from their experiments, which were grown at two levels of fertility, that a larger embryonic capital is only an

advantage when nutrients are in short supply. An experiment involving two seed sizes and two fertility levels, showed that an increase in soil fertility enables seedlings derived from smaller seeds to maintain an advantage when seeded earlier than the larger seeds.

A study of a more qualitative nature was made by McDaniel (1969), who investigated the relationship of seed weight, seedling vigour and mitochondrial metabolism in barley. He found that seedling fresh weight, seedling mitochondrial protein and mitochondrial biochemical activity were positively correlated with seed weight. Although the number of mitochondria per unit fresh weight was the same for all classes of seed size, relatively more mitochondrial protein was present in seedlings from large seeds, resulting in a higher respiratory activity. The greater energy production in seedlings from large seeds thus allows a higher growth rate of these seedlings than of the seedlings from smaller seeds of the same genotype (McDaniel, 1969).

Seed size, thus, affects early growth rate of seedlings and is therefore an important factor in determining the competitive advantage or disadvantage of a plant at the time that a shortage of growth factors occurs.

2.4.5 Effects of density on plant interactions

Interaction between plants will start earlier in dense stands than in more widely spaced plantings. However, there is no direct effect of plant density upon plant growth. All

responses to density are indirectly measured as responses to limits on growth factors. Using wheat plants, grown at four different densities, Clements et al. (1929) observed that the effects of density resembled the effects of a water shortage. Pot cultures with different levels of soil moisture, fertiliser and light intensity, confirmed their theories and they concluded that, under their growing conditions, with increasing density, competition for water is most severe, with competition for nutrients and for light playing important, but secondary, roles.

Harper and Clatworthy (1963) studied changes in light absorption in swards of *Trifolium repens* L. and *T. fragiferum* L. grown at two densities. For both species, initial differences between the two densities in light extinction and leaf area had almost disappeared after fifteen weeks of growth. Apparently light was the limiting factor at both densities and an LAI of about five for *T. repens* and of six for *T. fragiferum* was the maximum that could be maintained, under the provided light regime.

Increasing population density, therefore, may be regarded as an increase in competition for light, nutrients and water among associated genotypes. Donald (1958) emphasised that, even if competition occurs for only a single factor, there will be interaction between direct and indirect effects. Competition for nutrients, for example, may affect shoot growth, and this may modify competition for light.

Harper (1961) distinguished two ways in which plants may react to density. Firstly, an increased density may result in a reduced chance for survival. He described the results of studies concerning several species of *Papaver*. It appeared that most of these species regulate their numbers in response to increases in density of their own kind, independent of the density of other species. This forms an important mechanism in nature, which prevents elimination through crowding by neighbouring species.

Secondly, there may be a plastic reaction to density during the development of a plant. This response was illustrated by Harper with the following example, describing the growth of *Agrostemma githago* L. under various conditions of density and in different mixture situations. When grown in pure stand, the number of plants per unit area, which were produced from different amounts of seed, was fairly constant. All plants bore an approximately equal number of capsules and gave equal seed yields. In association with different species, however, the surviving plants bore an equal number of capsules but gave a different seed yield. Unmixed, the *Agrostemma* plants in the study gave about 30,000 seeds/sq.yd. In association with wheat, the same the number of plants produced about 12,000 seeds/sq.yd., and in association with sugar beets, about 22,000 seeds/sq.yd.

This type of response, when it occurs in a mixture of genotypes such as encountered in the early generations of a breeding program, could have important effects on the

outcome of selection. The occurrence of such interactions is suggested by observations made by Phung and Rathjen (1976, 1977), who reported that grain yield of wheat plants was affected by the frequency of plants of the same genotype, amidst a population of plants of a different genotype.

Genotypes in segregating populations of corn responded to changes in density with changes in seed yield (CIMMYT, 1972). They noted that density affected the selection of corn, and that different genotypes were selected at different plant densities.

A study of the effects of variation in spacing, seed size and genotype on plant-to-plant variation of wheat, showed that increased interplant spacing was by far the most effective in increasing plant-to-plant variation for characters, such as plant dry weight and yield components (Chebib et al., 1973). However, interaction between genotypes and variation in seed size also consistently, but insignificantly, increased variation among plants.

Contrary to the findings of Chebib et al., Kelker and Briggs (1978) observed a decrease in variance with increased spacing for several plant characters measured on seven cultivars of wheat. They concluded that the tendency for variance to respond to changes in spacing is cultivar specific, and that not all plant characters respond to the same degree.

Hozumi et al. (1955) used uniform seed of yellow dent corn to observe the growth of individual seedlings and their

response to neighbouring plants. The seeds were grown in boxes outdoors. They found that large plants in a row tended to suppress their neighbours, and vice versa, resulting in an alternation of large and small plants. This was clearly shown by auto-correlations of plant weights within a row. Correlations with first, third and fifth neighbours were negative, while correlations with second and fourth neighbours were positive. Plant weight in their study was estimated from stem diameter and plant height. The importance of plant shape to plant interactions was clearly illustrated by the observation that correlation coefficients of actual plant weight showed a similar pattern, but were much smaller. At wider spacing, the neighbour effects appeared to be restricted to first and second neighbours only (Yoda et al., 1957).

In an earlier paper by Kira et al. (1953), the authors found quite different results for the growth of soybean plants. In this study, an hexagonal planting arrangement was used, with equal distances between all plants. The correlation between the weight of an individual and the mean weight of the six nearest neighbours appeared to be positive rather than negative. The authors did not speculate on the reason for the observed behaviour. It can be noted, though, that while the corn experiment was performed in boxes, the soybean experiment was grown in the field where soil heterogeneity might have played a larger role. This would tend to create a positive correlation between neighbours

which were similarly affected by varying soil conditions. It is also possible that the different planting arrangement was responsible for the different results, because in rows, the effects of one plant are exerted onto two neighbours, while six neighbours are involved in the interactions between plants grown in hexagons. One can expect a proportional dilution of neighbour effects in this case, decreasing the strength of neighbour correlations.

Thus, because changes in plant density tend to change the time at which neighbour interactions start, one can expect neighbour interactions which are density specific. In a mixture of genotypes or species, the density of plants from the same genotype, as well as the density of plants from different genotypes may affect plant growth independently.

2.4.6 Changes in the distribution of characters during growth

The shape of the frequency distributions of various characters, assessed at different times during the growing season, is illustrative of the dynamic nature of the population. Mean and variance give only a partial description of the distribution curve. A more precise picture is obtained when skewness and kurtosis are included.

Skewness is a measure of asymmetry of the curve. A positively skewed distribution has a mean to the left of the median, and a 'heavy' positive tail (L-shaped). A negatively

skewed distribution has approximately a J-shaped form (Sokal and Rolf, 1969).

Kurtosis further specifies the shape of the curve. Generally, when no skewness is present, a positive kurtosis means that the character has more values around the mean and in the tails and less in the intermediate regions, than does a character with a normal distribution does. The curve is thus sharply peaked with flat long tails. A negative kurtosis, in the absence of skewness, indicates more values in the intermediate regions (Sokal and Rolf, 1969). However, many different shapes of curves may have similar values of kurtosis, and this parameter is not necessarily a measure of peakedness of the curve (Kendall and Stuart, 1977). Strongly skewed distributions tend to have a positive kurtosis, due to the heavy tail on one side of the curve.

Koyama and Kira (1956) pointed out that the frequency distribution of plant weight of many species was normal shortly after emergence, but became more positively skewed (L-shaped) with time. This effect was stronger at higher plant densities. On the other hand, plant height most often developed a distribution which was negatively skewed (J-shaped). The authors observed that higher mortality occurred in those stands which developed a skewed weight distribution during early growth, while in populations which kept a normal distribution, mortality was low. The two species for which height distributions were reported, corn and ragweed, both have a determinate growth habit. In these

plants, genetic factors impose an upper limit to plant height, while no lower limit is present. This could explain the J-shape of the distribution of height. No mention was made of a possible different shaped distribution for plants of an indeterminate growth habit.

Non-normal distributions were also observed on characters of barley, grown in simulated segregating rows at Beaverlodge, Alberta (H. A. Kelker, unpublished). The measured characters (the number of tillers, height, kernels per head and others) were those which are normally used as criteria for plant selection in a breeding program, and non-normality of their distribution could affect the accuracy with which superior genotypes are selected.

2.4.7 Effects of genotype interaction on grain filling and maturity

Although plant interactions can evoke responses in a great number of plant characters, the plant breeder is, ultimately, only interested in the final effect of these interactions on grain yield, and in many regions, on maturity.

Final crop yield of a high yielding dwarf wheat cultivar, Yecora, appeared to be well buffered against small reductions in crop photosynthesis at various times during the growing season (Fischer, 1975). Crop growth rate, on the other hand, responded to shading at any time. There are various phenomena which can explain the stability of crop

yield. For example, Fischer (1975) also observed that this cultivar adapts to variations in light intensity or plant spacing with variations in tiller survival. In this case morphological plasticity of single plants is related to stability of crop yield.

Another mechanism aiding the stability of crop yield was described by Evans and Wardlaw (1976). They reported that, of the dry matter which accumulates in grain on unstressed plants, 90 to 95% comes from photosynthates produced after anthesis. The remaining quantity comes from reserves stored in vegetative plant parts. Plants under stress from shading or defoliation, however, will draw upon reserves to a much greater extent.

Although actual grain filling does not start until several days after anthesis, shading immediately after anthesis had a significant effect on kernel weight of wheat (Ford and Thorne, 1975). Shading during this period affected the subsequent capacity of grains to accumulate carbohydrates, possibly through limiting the number of endosperm cells, or through a mechanism which limits the amount of carbohydrates that can be translocated. Shading during this period, however, did not affect the amount of nitrogen in the mature grains, thus resulting in grains with a relatively higher grain protein percentage (Jenner, 1979).

The negative correlation which exists between the number of kernels per plant and kernel weight (Fisher, 1975; Jenner, 1979), once more illustrates the mechanism through

which yield can be buffered against variations in individual yield components. Variations in the number of kernels per head were brought about by various degrees of shading in the period just prior to anthesis (Fischer, 1975). Adjustments in subsequent kernel size, however, could not completely compensate for the reduced number of kernels, and reductions in yield were observed as a result from pre-anthesis shading.

Effects of plant interaction on maturity have generally been overlooked in studies on mixtures of genotypes, possibly because visual assessment of maturity of single plants is generally inaccurate. More reliable measurements can be obtained from the moisture content of the grain as an indirect indication of maturity, although this is a very time consuming technique (Somerville, 1977).

One could, however, anticipate that genotype interactions may affect maturity of mixture components. For example, variations in the onset of flowering, related to varying levels of nutrients in the leaves, have been reported for several plant species (Aitken, 1974). Such a situation could arise from the unequal sharing of available nutrients by the components of a mixture. Variation in the onset of flowering may affect the timing of subsequent developmental stages. Somerville (1977) reported a high correlation between date of flowering and maturity for both wheat and barley.

2.5 Effects of interaction between genotypes on single plant selection

The need for early identification of genotypes which have good agronomic qualities and high yield was clearly demonstrated by Shebeski (1967). He showed with a theoretical example, that with advancing generations, the proportion of plants which can be expected to possess the best combination of genetic characters decreases very rapidly. Thus, selection should ideally take place in the F₂ generation.

It is possible to select for a number of simply inherited traits, such as disease reaction or height, at an early stage of a breeding program (Sneep et al., 1979). However, characters which are influenced by many different internal as well as external factors, such as yield, cannot be correctly assessed on a single plant basis. McGinnis and Shebeski (1968) illustrated the ineffectiveness of visual selection for yield in an F₂ generation of wheat. They compared the results of visual selection of single plants by three plant breeders, with the results of random selection. They found that there was no significant difference between the mean yield of the F₃-progeny plots derived from randomly selected lines and derived from lines selected by plant breeders.

Because visual selection of single plants for yield ~~per se~~ is ineffective, several studies have dealt with the question whether selection for other characters would be

effective in increasing yield.

Rasmusson and Cannell (1970) found selection for the number of heads in two populations of barley to be as ineffective as selection for yield itself. Yield was reduced when selection was practiced for high number of kernels per head. Selection for high kernel weight was effective in increasing yield in one of the populations.

An increase in grain yield, associated with mass selection for large kernel size in wheat, was found by Derera and Bhatt (1972). This increase appeared not to be correlated in any way with quality characters, such as test weight, milling extract, wheat protein, flour protein and kernel hardness (Bhatt and Derera, 1973). Röbbelen (1979), however, explained that in the past, increased grain yields of many crops have led to a relative reduction in seed protein, which, in cereals, is mainly due to the increase of the endosperm relative to the embryo.

Morphologic and agronomic characters of 22 cultivars of wheat were studied by Nass (1973). He found that the yield per ear, the number of heads per plant, harvest index, and kernels per head were all positively associated with plot yield. Yield per head and heads per plot had the strongest associations, but because the yield per head and heads per plant are negatively correlated with each other, it would be difficult to select for both traits at the same time. Nass suggested that selection for moderate expression of these two characters could lead to increased yield.

Hamblin and Donald (1974) found no consistent correlations between yield per head and ears per plant in the F3 and the F5 generations of a barley cross. But they did find that tall F3 plants with long leaves tended to give low yields in the F5 generation. They suggested that the greater amount of interaction between genotypes which occurs in the F3 generation caused suppression of the higher yielding types, resulting in the observed negative correlation.

It was concluded from studies on barley that interactions between genotypes caused significant shifts in the expression of plant yield, heads per unit area, and the number of kernels per head, causing genotypes with a high yield potential to yield poorly (Wiebe et al., 1961). If yield in monoculture is the criterion for selection, the poorest rather than the best plants should thus be selected from the early generations.

In the past, yield improvements have been paralleled by a steady increase in harvest index, a character which appears to be relatively insensitive to variations in environmental conditions (Donald and Hamblin, 1976). However, this was an unplanned side effect, since no selection for harvest index was practiced. The question can be asked whether the effects would be reversible: would selection for high harvest index be accompanied by an increase in yield? From studies with F3 and F5 generation plants of barley, it was concluded that harvest index is not

predictive for yield from one environment (F3) to another (F5) (Hamblin and Donald, 1974). However, comparison of single plants of wheat, grown in pots in the greenhouse and in plots in the field, showed that single plant harvest index is a good predictor of crop yield in the field (Syme, 1972).

Selection for harvest index in the F2 generation of two wheat crosses doubled the grain yield per plant in the F3 generation (Bhatt, 1977). In addition, the positive correlation of yield with harvest index was enhanced. While selection for low harvest index resulted in a correspondingly low harvest index in the F3 generation, selection for high harvest index resulted in a population segregating for high and medium harvest index, thus allowing further selection for this character.

Although Donald and Hamblin (1976) reported that harvest index is relatively little affected by variations in density, resulting in a low genotype x density interaction, Nass (1980) found that indirect selection for grain yield through harvest index gave better results when practiced at commercial density than when practiced at low density. He ascribed this to the smaller plant-to-plant variation for harvest index which exists at high density.

The value of selection for harvest index was studied by Rosielle and Frey (1975a,b), using 1200 F9-derived lines of oats, grown in hill plots. They concluded that selection for harvest index alone was 43% as effective as was selection

for grain yield. If selection for height and maturity were combined with selection for harvest index, this percentage increased to 70%, indicating a good relationship between yield and harvest index within the limits of acceptable height and maturity, in homozygous lines.

Harvest index of main shoots appeared to be an even better indicator of crop yield. (Fischer and Kertesz, 1976). Using 30 genotypes of bread wheat, correlation coefficients were computed between the yield of plots at commercial crop spacing with harvest index of main shoots, harvest index of whole plants and grain yield of spaced plants, respectively. They obtained values 0.57 (sign., $\alpha = 0.01$), 0.49 (sign., $\alpha = 0.01$) and 0.20 (n.s.) respectively.

Because interaction between genotypes evokes reactions which are specific to each mixture situation, it is not surprising that Hamblin and Rosielle (1978) found great differences between genetic parameters of crosses when estimated in mixture and when estimated in monoculture. They demonstrated, using published data from different authors, that interaction between genotypes can increase or decrease the observed additive and dominance effects by a considerable amount. They showed cases where these parameters, measured in a monoculture and measured in a mixture, differed by more than 100%. In some cases, the values were about equal in magnitude, but opposite in sign.

In addition to an effect on the mean values of characters, positive and negative effects of plant

interaction on the variances were reported (Hamblin and Rosielle, 1978). As a result, estimates of heritability which are based on the estimation of variance components in a mixture of genotypes, would be either under- or over-estimated. 'This may lead to excessive effort being put into crosses and parents where competitive effects have increased heritability estimates and to the rejection of crosses and parents where they have reduced heritability estimates.' (Hamblin and Rosielle, 1978). The authors then suggested that, if early generation selection is to be effective, techniques should be developed which accurately assess the confounding effects of competition on the estimation of genetic parameters, and which could be used to correct these parameters for plant interaction effects.

In order to be able to assess the confounding effects of interaction between genotypes on the expression of genetic characters, it is necessary to know which plant characters are affected by genotype interaction, how interaction affects these characters and which characters of neighbouring genotypes are associated with these effects. The present study was conducted in an attempt to contribute fundamental knowledge on these subjects, focusing on the implications of genotype interaction for breeding of spring wheat.

3. Short Description of the Experiments

The experiments for this study were conducted during the growing seasons of 1977, 1978, and 1979, and were designed to investigate different aspects of the interaction between wheat genotypes.

During the first year of the study, eight genotypes and their binary mixtures were planted accurately at eight different interplant spacings. Morphologic characters were measured on single plants at maturity. It was hoped to learn from this test how the effects of competition were expressed at various spacings in each of the studied genotypes.

For the second year of the study, five of these genotypes were grown at three different spacings in monocultures and binary mixtures, and a detailed study was made of the relationships between plant characters of competing genotypes. Effects of interaction on mean plant performance as well as on plant to plant variation were determined.

During the last year of the study, the role of seed size and subsequent plant development on the development of adjacent plants in a row was investigated. This experiment involved only monocultures of the five genotypes used in the second year.

In addition to the single plant experiments, replicated yield trials, containing eight genotypes in monoculture and all possible binary mixtures, were grown in each of the three years. These tests were conducted to illustrate how

each of the genotypes affected mixture yields, and how the performance of mixtures varied over the three years.

4. Materials and Methods - General Information

The specific procedures followed for each of the experiments in this study are discussed in the sections preceding the presentation of the results for each test. General information pertinent to all the experiments is given in the following sections.

4.1 Characteristics of test sites

Experiments were conducted at the Edmonton Research Station in 1977 and in 1979, and at the Ellerslie Research Station in 1978. Both stations are operated by the University of Alberta, Edmonton, Alberta, Canada.

The sites are located about 10 km apart, at a latitude of 53° 24' N and at an altitude of 694 m above sea level. Appendix 1 shows the mean monthly temperatures and precipitation during the three growing seasons in which the experiments were conducted.

Both sites are located in the thin black soil zone and the soil is classified as silty clay loam.

Fertilizer was applied in each spring prior to seeding, at rates recommended for wheat, based on soil analyses conducted by the Soil and Feed Testing Laboratory of Alberta Agriculture (Appendix 2). During the fall of 1977 and 1978, Avadex was applied to the test sites for control of wild oats. In 1977 and 1978, herbicides were applied during the early stages of growth, for control of the common broadleaf

weeds, stinkweed, green smartweed, pigweed and hempnettle (Appendix 2). In addition, all plots were hand weeded when necessary.

4.2 Plant material used

Eight wheat genotypes were used in the test: Pitic 62, Glenlea, Park, Neepawa, 70M110001, 70M009002, Norquay and NB701. Park and Neepawa are Canada Western Red Spring wheats, while the other genotypes are Utility type wheats. The genotypes were chosen to represent a wide range of agronomic characters such as height, maturity, tiller number and seed size (Appendix 3). Seven of these genotypes had been previously studied, providing extra information on their performance at the Edmonton and Ellerslie test sites (Attinaw, 1977; Somerville, 1977).

As a seed source for Pitic 62, Glenlea, Park, Neepawa and Norquay, foundation seed or registered seed was used. For the genotypes 70M110001, 70M009002 and NB701, clean, sound seed was obtained from yield trials conducted as part of The University of Alberta wheat breeding program.

In each year, kernel weights and germination rate of all genotypes were determined on the seed lots to be planted (Appendix 4). Germination tests were conducted in petri dishes containing two rounds of filterpaper (Wattman, no. 40) and 4 ml of distilled water. The dishes, containing 100 seeds each, were placed in a Seedburo incubator, model 2100,

at 36°C, and germination was determined at 24, 48, 72 and 96 hrs.

5. Interaction Between Genotypes at Different Interplant Spacings

5.1 Materials and methods

5.1.1 Field plot design

During the first year of the study, monocultures and binary mixtures of the eight genotypes were tested over a wide range of spacings, to observe genotypic differences in response to variations in the environment.

Each of these mixtures and monocultures was grown at eight different spacings, ranging from 7 to 60 cm between plants. To make the most efficient use of space, a 'wheelplot' design was used, in which each wheelplot represented one mixture or monoculture grown at seven spacings. Seeds were placed on a grid made up of concentric circles and 'spokes', and seeds of the competing genotypes were alternated on the spokes and circles, such that each plant was surrounded by four plants of the associated genotype. In proceeding outward from the centre of the circle, the distance between plants increased as the spokes diverged, and the distance between concentric circles increased.

Plant density was calculated as the average of the distance from one plant to its four immediate neighbours, which were situated on either the same spoke or on the same

circle. The resulting spacings were 7, 9, 12, 15, 19, 24 and 31 cm between plants or 204, 124, 69, 44, 28, 17 and 10 plants per m^2 respectively. Commercial seeding rates in the Edmonton area range from 56 to 101 kg/ha (Alberta Farm Guide, 1976), which converts to approximately 140-250 seeds/ m^2 .

Each plot had the shape of a three quarter circle with a radius of 2 m, containing twenty four spokes and nine concentric circles. The plants on the innermost and outermost circles, as well as on the first and the twenty fourth spoke, were discarded as guard plants.

In addition to the seven spacings in the wheelplots, each genotype was grown in a rectangular plot, containing 10 plants each, planted at an equidistant spacing of 60 cm. At this spacing plant interactions were assumed to be absent.

5.1.2 Seed preparation and data collection

To reduce seeding time, all seeds were glued onto cotton string (10/6 S), made by Dominion Textile (Texmade), using LePage's Multi Use Bondfast. This method had previously been used in the field for several years with good success (Dr. V. Burrows, Chief, Cereal Section, Research Branch, Ottawa, Agriculture Canada, 1976; personal communication). To keep the 24 strings (spokes) of each plot separated, they were labelled and tied, in the order in which they had to appear in the field, onto a stake which at seeding time could be placed in the centre of the plot. A

strip of paper was subsequently placed on top of the strings and strings and paper together were rolled around a cardboard tube.

To facilitate placement of the strings in the field, a square metal frame was constructed, containing a bar which could rotate around a central axis. Furrows were drawn with a metal shoe which slid along this bar. After placement of the strings, the furrows were closed and packed using a board.

Before harvest, the location of each plant was recorded on plot maps and all plants were labelled. All plants which had all four neighbours present were harvested when 75% of the tillers appeared to be ripe. Measurements were taken on plant height, height of the flag leaf blade, the number of tillers, the number of fertile heads (heads with a minimum of five seeds), the number of kernels per plant, grain yield per plant, and above ground plant dry weight. From these measurements, the following characters were calculated: extrusion length (calculated as plant height - height of the flagleaf blade), the number of kernels per head, weight per 1000 kernels, the yield per head and harvest index (calculated as plant grain yield/ plant dry weight).

Because the present study approached the problem of genotype interaction as it is encountered by the plant breeder when he makes selections in the field, measurements of height and related characters were taken on two randomly chosen tillers of each plant. In this way it was hoped to

obtain a more realistic estimate of the variation which is observed in the field, than would be obtained from measurements on the main stem only.

5.2 Analysis of the data

The wheelplots were arranged according to a randomised block design with two replications which each occupied two banks of plots. The 60 x 60 cm spaced plants were replicated four times and grown at the end of each bank.

Because the spacing treatments were arranged systematically within the wheelplots, the requirements of randomisation were not met. The spacing effects indicated by the analysis of variance are thus confounded with effects due to treatment arrangement. The results cannot be considered as more than an indication of possible effects of spacing and will have to be further tested in subsequent experiments.

5.3 Results

Pitic 62 failed to germinate sufficiently and all treatments involving this genotype were dropped from the 1977 tests. Additional germination and or growth problems were encountered in the remaining plots, resulting in a very low number of usable plants overall. More than half of the plots (31 out of 56) had a survival rate of less than 75%. Recorded survival rate in some plots was as low as 43%,

while a few plots (including all 60 x 60 cm spaced plants) were abandoned completely.

In search for an explanation for the poor germination, soil tests were performed in the fall of 1977. The results indicated levels of available P ranging from 39 to 47 lb/2M on the east side of the field to 14 lb/2M along the west side of the field. Although no specific symptoms of P-deficiency were noted during the growing season, all but four of the sparsely populated plots were located in the western halves of the banks, suggesting a direct or indirect relationship between the phosphorus content of the soil and survival rate.

Seeding was interrupted by two days of heavy rain, causing some of the seeds to become uncovered, which probably added to the low germination rates in some plots.

In an effort to get as much information from the data as possible, the test was treated as a completely randomised design. Plants from both replicates were pooled, and only those treatments were included for which data had been recorded on a minimum of five plants. For none of the genotypes were data available from all possible genotype combinations (Appendix 5). Means and variances of the characters measured at each treatment illustrate the observed range of performance (Appendix 6). Since data about monoculture performance were obtained for only four genotypes (Glenlea, Park, 70M110001 and Norquay), tests for the effects due to genotype interaction had to be limited to

these four genotypes.

Spacing effects and genotype effects were significant ($\alpha \leq 0.01$) for all characters (Table 1). Mixing significantly affected height of the flag leaf, plant height, 1000 kernel weight and harvest index. However, interactions between effects of genotype interaction and spacing were significant for plant weight, yield and the number of kernels per plant, indicating that neighbouring plants affected these characters at some of the spacings tested. Interactions between the effects of genotype interaction and genotype were significant for all characters except the number of heads, the number of tillers, and kernels per plant, suggesting that the genotypes differed in their response to genotype interaction. Three way interactions were significant for the number of heads, the number of tillers, weight, yield, and the number of kernels per plant.

Comparison of mixture and monoculture performance of each of the four genotypes at each of the spacings tested, indicated the specific densities at which the various characters were affected (Table 2). While interaction - indicated by significant t-values - was evident for Glenlea at a density of 10 plants/m², Park was only affected at 124 and 69 plants/m² and 70M110001 only at 124 plants/m². None of the genotypes showed significant effects of interaction at 44 and at 204 plants/m². It is likely that at the highest plant density, the general effects of density on plant growth were so strong that the more subtle effects of

Table 1. The effect of genotype, genotype mixing, and interplant spacing on single plant characters, as determined by analyses of variance.¹

All plants were grown in wheelplots in 1977, and measured at maturity. The data are only from plants which had all four neighbours present.

Source of variation	df	Mean squares of characters ²											
		T	H	Wt	Y	FL	Ht	ExL	K/P	K/H	Y/H	Kwt	HI
Genotypes (G)	3	160.3**	96.2**	6645**	1162**	3510**	32504**	23481**	280477**	2665**	16.35**	2299**	0.191**
Mixing (M)	1	0.0	13.8	1135	109	505**	8859**	17	1264	360	1.16	444**	0.037*
Spacings (S)	6	1915.1**	907.2**	31510**	7103**	83**	346**	278**	3988200**	11672**	15.93**	153**	0.082**
G × M	3	7.1	19.0	1008*	237*	986**	3614**	201**	77860	1668**	4.46**	916**	0.118**
G × S	18	49.5**	46.7**	1035**	243**	22	50	37	74868*	341	0.67	18	0.015*
M × S	6	42.7	28.0	1062**	252**	22	41	19	98303*	610	0.56	59	0.009
G × M × S	9	40.3	41.0**	1183**	198*	34	83	40	83213*	263	0.96*	40	0.013
Residual	574	22.5	16.3	361	94	29	80	55	42857	325	0.46	42	0.009

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Abbreviation of characters:

T = Number of tillers per plant

H = Number of fertile heads per plant

Wt = Plant dry weight

Y = Grain yield per plant

FL = Height of the flag leaf blade

Ht = Shoot length

ExL = Extrusion length

K/P = Number of kernels per plant

K/H = Number of kernels per head

Y/H = Grain yield per head

Kwt = 1000 kernel weight

HI = Harvest Index

Table 2. Comparison of the means of characters of single plants, grown in monoculture and in mixture, at various plant densities, by means of Students t-test.¹

All plants were grown in wheelplots in 1977, and measured at maturity. The data are only from plants which had all four neighbours present.

Genotype	Density ² (plants/m ²)	df	t-values for measured characters ²									
			lit	H	T	Wt	Y	K/P	K/H	Y/H	Kwt	HI
Glenlea	204	22	0.54	0.21	0.31	0.71	0.00	0.19	0.48	0.91	0.24	2.24
"	124	33	1.28	0.06	1.27	0.58	1.07	1.14	2.37*	2.23*	0.52	1.76
"	69	33	1.01	0.63	1.66	0.90	1.88	1.63	2.46*	2.79**	1.89	1.85
"	44	27	1.44	0.71	0.94	0.29	0.37	0.24	1.16	0.98	0.09	0.92
"	28	18	0.51	2.23*	3.46**	2.47*	3.03**	2.86**	0.31	0.45	0.43	2.66*
"	17	18	0.71	1.04	0.06	0.13	0.44	0.55	2.81**	2.15*	1.09	0.80
"	10	17	0.57	0.29	1.37	0.73	2.39*	2.72**	2.23*	2.00	2.38*	2.15*
Park	204	23	1.39	0.13	0.17	0.40	0.52	0.33	0.71	0.97	0.89	0.66
"	124	39	1.59	2.01*	2.45*	1.62	1.77	1.86	1.16	1.22	0.67	1.35
"	69	30	3.54**	1.20	0.82	1.31	1.18	1.79	0.33	0.60	0.41	1.41
"	44	26	1.86	0.06	0.27	0.16	0.66	0.06	0.18	1.05	1.83	1.46
"	28	27	0.29	0.91	0.31	0.35	1.16	0.83	0.11	0.74	0.66	1.79
"	17	24	0.34	0.26	0.45	0.47	1.26	0.57	0.05	0.45	0.71	1.59
"	10	24	0.50	1.78	0.56	0.90	0.89	0.74	1.15	0.94	1.38	1.68
70M110001	204	23	0.20	0.28	0.22	0.25	0.73	0.54	1.72	1.98	0.40	1.82
"	124	20	0.93	1.37	2.09*	2.26*	2.31*	2.28*	1.43	1.78	1.01	0.88
"	69	21	1.86	0.60	1.66	1.51	0.20	0.59	0.28	0.85	1.63	1.15
"	44	25	1.19	0.28	0.40	1.11	1.64	1.54	0.95	0.27	0.25	0.44
"	10	17	0.78	0.35	0.77	0.90	0.92	0.91	1.55	1.59	0.00	0.45
Norquay	124	10	0.59	0.28	1.06	0.13	0.90	0.98	2.30*	2.29*	0.72	0.42
"	10	15	0.41	0.28	0.13	0.14	0.92	0.68	1.21	1.46	1.73	1.35

1. * significant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$

2. character abbreviations defined in Table 1.

interaction between different genotypes could not be distinguished with the experimental techniques used.

5.4 Discussion

Because the data used for the analysis of this test come from a small number of observations only, further experiments are necessary to verify the conclusions about the effects of plant interactions on the genotypes involved over the range of spacings tested. Nevertheless, a number of comments can be made regarding the observed effects.

The fact that the genotypes differed in their response to genotype interaction, and that each did so at different spacings, indicates that interpretation of mixing experiments performed with a limited number of genotypes and environments could lead to variable conclusions.

It appeared that Glenlea, which is the tallest, latest and most vigorous of the four genotypes, was the only genotype to show effects of genotype interaction at a density as low as 10 plants/m². Possible methods of interaction are restricted to light interception by neighbouring plants, and interaction between root systems. Since shading by neighbours only occurred during part of each day, interaction between root systems is probably the most influential factor at this interplant spacing.

6. Relationships between Plant Characters Measured on Mixed Genotypes

6.1 Materials and methods

In 1978, a test was conducted to investigate, in more detail than in 1977, the phenotypic responses of genotypes to genotype interaction at different spacings. To keep the experiment manageable, the number of genotypes had to be restricted to five: Pitic 62, Glenlea, Park, 70M009002 and Norquay. They were chosen, based on the 1977 yield trials, to represent a wide range of Average Mixture Efficiency (see Section 8.2, p.92), and for their recognisability in a mixture. They were grown in rows 30 cm apart, at plant spacings within rows of 1, 3 and 9 cm. This resulted in densities of 333, 111 and 37 plants/m². Seeds were glued onto strings as described in Section 5.1.2, and placed in furrows which were drawn with a pointed stick along a board.

A split plot design was used with three replicates. The main plot treatments were mixtures and monocultures, and the subplot treatments were spacings. The mainplots, which were 6 m long, were divided into three subplots of equal length. Each plot consisted of three rows of which only the middle one was sampled. Three plants at each end of each subplot were discarded as guards.

From both the 3 cm spacing and the 9 cm spacing, a random sample of six plants per genotype was taken at

maturity, using only plants which had both neighbour plants present. Measurements were taken on the height of the the flag leaf blade, the extrusion length (height above the flag leaf blade), the head length, the yield per plant, the number of kernels per plant, the number of tillers per plant, the number of fertile heads per plant, and plant dry weight. From these measurements were computed the number of kernels per head, the yield per head, the 1000 kernel weight and the harvest index. As in 1977, measurements on height and related characters were taken on a random sample of two tillers per plant.

It was the intention to examine the root distributions of the genotypes in mixture, and therefore the complete bulk yield test was replicated several times, so that enough extra plots were available for destructive soil core sampling. Unseasonably high soil moisture content, however, made it impossible to obtain good soil cores, and this objective was abandoned. Thus, extra plots were available, and tiller samples were taken from these at flowering and at the mid-dough stage. Measurements were taken on the flag leaf area, the height of the flag leaf blade, the tiller length, the extrusion length and the head length. Each sample consisted of a 1 m section of row, chosen at random from one of the middle rows of the plots. The samples taken at the two developmental stages were not replicated, so that differences between mixing treatments may be confounded with differences among plots. At each stage, sampling was

completed in one day, so that differences among the genotypes will reflect genotypic differences in rate of development.

6.2 Analysis of the data

Because it was not possible to accurately separate the plants which were grown at the 1 cm spacing, only data obtained from the 3 cm and the 9 cm spaced plants were included. The data were analysed to detect effects of genotype interaction on within genotype variation, as well as on mean plant performance.

Variance, skewness and kurtosis of the measured characters were computed for each sample, as well as for the combined mixture data for each genotype. Because significant deviations from normality occurred, Bartlett's test for homogeneity of variances could not be used, since this test is extremely sensitive to non-normality (Scheffé, 1959). Scheffé described an approximate test for the comparison of variances, based on the natural logarithms of the sample variances. This analysis was used to test the effect of genotype, genotype interaction and spacing on the variances of all characters.

Overall differences in variation between plants grown in monoculture and plants grown in mixture, were determined by means of a variance ratio F-test, using the mean variances of all genotypes grown in mixture and grown in

monoculture. For these comparisons the natural logarithms of the data were used (Lewontin, 1966).

Although the test was designed as a split plot, it was decided that an error term with more degrees of freedom was desirable, which would make it possible to detect smaller effects of genotype interaction than would be possible with a split plot analysis of variance. Therefore a randomised block analysis of variance was used to test the effects of genotype, spacing and genotype interaction.

Mixture efficiency was expressed for components of yield and plant weight, using the technique described by de Wit (1960), as the 'Relative Yield Total' (RYT):

where Y_{AB} and Y_{BA} are, respectively, the mean plant yields, or values of the character concerned, of the genotypes A and B when grown in association with each other, and Y_{AA} and Y_{BB} are the monoculture yields of the two genotypes. The expressions Y_{AB}/Y_{AA} and Y_{BA}/Y_{BB} are called the 'Relative Yield' (RY) of genotypes A and B, respectively, expressing the ratio of the yield of a genotype in mixture to its yield in monoculture. A value of 1 for the RY of a mixture component indicates that the effects of interaction between genotypes are not different from those which plants of the same genotype have on each other. A RY greater than 1 suggests that the associated genotype makes demands on the

environment which are either different from, or less than, those of the genotype under investigation. A RY of less than 1 indicates that interaction between the genotypes negatively affects the growth of the genotype in question, compared to its growth in monoculture.

A RYT of 1 would indicate effects of a compensating nature, or the absence of any effect on either of the components. A RYT greater than 1 suggests that the genotypes are, at least partially, occupying different niches, and thus are not sharing the same supply of resources. A value less than 1 indicates an antagonistic effect of one or both genotypes on their associate.

Both RY and RYT values were computed for mixtures and their components.

Since no simple test is available to determine whether RY or RYT values differ significantly from 1, they were evaluated with a t-test, comparing monoculture and mixture values. RY values were called significant if the difference between mixture and monoculture yield differed significantly from 0. Significance of the RYT values was determined using a t-test comparing expected yields as can be computed from monoculture values, with observed performance in mixture.

Within each individual plant, many characters are correlated. When investigating the relationships between competing plants, these within plant correlations can play a confounding role. Unfortunately, the number of genotype combinations in the experiment yielded an insufficient

number of degrees of freedom to investigate partial correlation coefficients between all characters of associated genotypes. Only correlations between character pairs have therefore been investigated. For this, multiple regression analyses were used, using indicator variables to correct for replicate effects (Steel and Torrie, 1980).

6.3 Results

During the growing season, two large bare spots, in which no plants grew, occurred in the plot area. Soil tests, performed after harvest to determine levels of available soil nutrients, soil pH and physical soil characteristics, did not reveal any abnormalities which could be related to the bare spots. All monoculture plots of Pitic 62 happened to be planted in these areas, so that no comparisons could be made between the performance of this genotype in monoculture and in mixture. Additional mishaps at harvest time resulted in the loss of several more treatments. For each genotype, mean values of the measured characters, when grown in monoculture and in mixture at 3 cm and at 9 cm spacings, are given in Appendix 7.

Although one can expect genotype interactions to affect flowering time and subsequent maturity of the mixture components (Aitken, 1974; Somerville, 1977), measurements of maturity on single plants were not made, because the methods available for rapid screening of a large number of samples

are generally inaccurate (Somerville, 1977). Many more replications would have been needed than were available. Visual assessment of genotype maturity in mixture, however, did not indicate any effects of genotype interaction, and no data on this character have been reported.

6.3.1 Effects of genotype interaction on plant-to-plant variation

An analysis of variance using the natural logarithm of the sample variances, showed no effect of genotype interaction on plant-to-plant variation in any of the characters (Table 3). Significant differences between genotypes occurred for variances of all characters except the number of tillers, the number of heads, kernel weight and harvest index, and changes in spacing affected the number of tillers, the number of heads, plant weight, yield, kernels per plant and extrusion length. When, for each genotype, the results of all mixtures were combined, however, variation was, on the average, greater in mixture than in monoculture for the number of tillers, plant weight and yield at the 3 cm spacing, and for kernel weight at the 9 cm spacing (Table 4). Harvest index, height of the flag leaf, extrusion length and height were less variable in mixture than in monoculture at the 3 cm spacing, while kernel weight, height, and extrusion length showed a lesser variability in mixture than in monoculture at the 9 cm spacing.

Table 3. Effects of genotype, genotype mixing and interplant spacing, on the variance¹ of single plant characters, as determined by analysis of variance².

All plants were grown in four-row plots in 1973. The data are from randomly selected plants, which had both neighbours present, and which were measured at maturity.

Source of variation	df	Mean squares of characters ³												
		T	H	Wt	Y	FL	Kwt	ExL	HI	FL	Ht	HL	ExL	Y/H
Genotypes (G)	3	0.66	1.13	4.13**	4.58**	2.29**	1.49	4.02**	0.16	2.33**	5.47**	2.78**	3.14**	5.40**
Mixing (M)	1	0.83	0.13	0.02	0.22	0.20	0.91	0.50	2.13	0.47	0.40	0.70	0.09	2.67
Spacings (S)	1	51.37**	54.88**	67.18**	66.95**	68.37**	0.85	1.19	0.03	0.01	0.17	0.44	2.74*	0.04
G × M	3	0.24	0.17	0.28	0.12	0.09	4.45*	0.22	0.27	0.72	1.60	0.93	0.47	0.17
G × S	3	0.97	0.38	0.62	0.57	0.75	0.92	0.17	0.00	1.11	2.04	0.20	0.30	0.47
M × S	1	0.95	0.08	0.01	0.04	0.01	0.01	0.13	0.49	0.18	0.02	3.16	0.72	0.01
G × M × S	3	0.59	0.33	0.34	0.36	0.20	0.48	0.15	1.92	0.36	0.18	0.10	0.40	0.22
Residual	66	0.57	0.48	0.44	0.43	0.46	1.46	0.95	1.21	0.59	0.83	0.70	0.67	0.87

1. The natural logarithm of the variances were used.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 1. HL = Head length.

Table 4. The effects of genotype mixing and interplant spacing on the average variation among plants, of single plant characters, as determined by a variance ratio F-test¹.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character ²	Inter-plant spacing (cm)	Coefficient of variation ³		F-values	
		Monoculture	Mixture	F ₁ ⁴	F ₂ ⁵
T	3	25.1	36.0	2.06**	2.01**
H	3	28.2	31.7	1.26	1.82*
* Wt	3	29.5	37.6	1.63*	1.68*
Y	3	33.1	39.0	1.39	1.48
K/P	3	31.2	36.6	1.38	1.68*
Kwt	3	7.6	8.9	1.37	2.04** ⁶
K/H	3	18.5	19.5	1.11	1.01
HI	3	12.1	8.4	2.08**	1.89**
F1	3	14.7	13.3	1.22	1.28
Ht	3	12.2	9.5	1.64*	1.75**
Ex1	3	17.5	14.8	2.08**	2.32**
HL	3	9.4	13.9	1.38	1.22

Character ²	Interplant spacing (cm)	Coefficient of variation ³		F-values	
		Monoculture	Mixture	F_3^7	
T	9	35.6	38.7	1.18	1.16
H	9	38.0	38.9	1.05	1.51**
Wt	9	38.2	40.3	1.11	1.15
Y	9	40.3	42.3	1.10	1.18
K/P	9	40.4	41.6	1.06	1.29*
Kwt	9	5.3	10.0	3.56**	1.26
K/H	9	18.6	18.0	<i>1.06</i>	<i>1.18</i>
HI	9	8.8	9.0	1.05	1.15
F1	9	13.0	13.4	1.06	1.01
Ht	9	9.2	9.0	<i>1.03</i>	<i>1.10</i>
Ex1	9	11.5	11.4	<i>1.02</i>	<i>1.69**</i>
HL	9	9.5	12.7	1.08	<i>1.04</i>

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$
2. Character abbreviations defined in Table 1. HL = Head length.
3. Averages of the coefficients of variation of four genotypes.
4. $F_1 = s^2(\ln x, \text{mixture}) / s^2(\ln x, \text{monoculture})$, df(180,60)
5. $F_2 = s^2(\ln x, 9 \text{ cm, monoculture}) / s^2(\ln x, 3 \text{ cm, monoculture})$, df(60,60).
6. F-values given in italics are the reciprocal of the values defined in footnotes 4, 5 and 7.
7. $F_3 = s^2(\ln x, 9 \text{ cm, mixture}) / s^2(\ln x, 3 \text{ cm, mixture})$, df(175,180).

Values of skewness and kurtosis averaged over the four genotypes grown in monoculture and in mixture, are given in Appendix 8. For some characters, in particular kernel weight and harvest index at the 3 cm spacing and number of heads and kernel weight at the 9 cm spacing, skewness was stronger in mixture than in monoculture. Other characters, such as kernels per head and height of the flag leaf at the 3 cm spacing and height at the 9 cm spacing, showed a skewed distribution in monoculture and a near normal distribution in mixture. In most cases, the kurtosis was less in mixture than in monoculture, indicating that, in mixture, more values occurred in the intermediate regions, with a lower concentration of values around the mean and in the tails. An analysis of variance, performed on the values of skewness and kurtosis, did not detect any significant effects of genotype interaction. However, the values were based on samples of only six plants per replicate. An analysis based on larger numbers of plants would be necessary to draw more meaningful conclusions with respect to the effect of genotype interaction on skewness or kurtosis.

6.3.2 Effects of genotype interaction on the expression of various plant characters

Although it was demonstrated in the previous section that the distributions of most characters deviated significantly from normal, no suitable transformations were found to correct this. Analyses were thus performed on

untransformed data.

As expected, the genotypes differed significantly from each other for most characters (Table 5). Mixing of plants with individuals of a different genotype had a significant effect only on head length, on kernels per head and on yield per head. However, genotype x mixing interaction effects were significant for all characters except height of the flag leaf, plant height, kernels per head and harvest index, suggesting differences between the genotypes in their reaction to genotype interaction.

All characters except height and harvest index were affected by an increase in spacing, and replicate effects were significant for extrusion length, 1000 kernel weight and harvest index. Genotypes differed for most characters in their response to spacing, as indicated by the significant genotype x spacing interactions. Mixing x spacing interactions were only significant for weight and harvest index.

6.3.3 Relative performance of genotypes in mixture

To evaluate the effect of genotype interaction on each character in each genotype, RY values were calculated (Table 6), and the effects of genotype interaction were tested for significance with a t-test. It can be seen that Glenlea, in most cases, yielded better in mixture than in monoculture. This effect was associated with an increased number of heads, and to a lesser extent with an increased

Table 5. The effect of genotype, genotype mixing, and interplant spacing on single plant characters, as determined by analyses of variance¹.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present and which were measured at maturity.

Source of variation	df	Mean squares of characters ²										
		T	H	Wt	Y	FL	HL	K/P($\times 10^{-3}$)	K/H	Y/H($\times 10^2$)	KWt	HL($\times 10^{-3}$)
Genotypes (G)	3	5	24**	1794**	399**	9857**	1318**	320**	76**	4098**	2496**	5641**
Mixing (M)	1	5	1	164	18	74	59	23**	15	528**	121**	36
Spacings (S)	1	1340**	953**	22031**	4338**	934**	19	1057**	40**	3338**	932**	314**
Replications	2	2	1	2	5	29	41	119*	2	5	9	1
G x M	3	20	16**	444**	91**	11	77	202**	6**	36**	102	39*
G x S	3	11	6	600**	106**	167*	42	89*	5*	23*	25	6
M x S	1	1	3	3	7	39	1	58	0	2	2	0
Residual	467	5	4	73	15	48	30	33	2	8	46	12
											14	2

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1. HL = Head length.

Table 6. Comparison of single plant characters of four genotypes, in monoculture and in mixture, at two interplant spacings, by means of 'Relative Yield' (RY) values^{1,2}.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were measured at maturity.

Mixture	RY values for measured characters ³											
	Y		T		H		Kwt		Wt		K/H	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
Glenlea + Pitic 62	0.96	1.13	0.87	0.97	0.89	1.11	1.06	1.00	0.93	1.06	1.06	1.01
+ Park	1.23	1.66**	1.24	1.51*	1.16	1.67**	1.06	1.04	1.27	1.55*	1.02	0.97
+ 70M09002	1.21	1.20	1.07	1.24	1.11	1.24	1.04	1.04	1.19	1.17	1.07	0.95
+ Norquay	1.34*	1.37	1.21	1.34	1.17	1.54*	1.09	0.94	1.34	1.27	1.06	0.90
Park + Pitic 62	0.70*	0.62*	0.67*	0.60**	0.66**	0.66	0.93	0.98	0.68*	0.57**	1.15	0.93
+ Glenlea	0.64*	0.59**	0.81	0.78	0.78*	0.83	0.93	0.91	0.65**	0.60**	0.92	0.76**
+ 70M09002	0.74	0.71*	0.91	0.76	0.85	0.81	0.94	1.01	0.75	0.70*	0.92	0.88
+ Norquay	1.12	0.74	1.03	0.72*	1.00	0.77	0.98	1.01	1.09	0.74*	1.16	0.95
70M09002 + Glenlea	0.75*	0.82	0.97	0.91	0.97	0.98	0.94	0.94	0.75*	0.78	0.83*	0.89*
+ Park	0.82	1.00	0.90	0.90	0.91	0.95	0.97	0.98	0.83	0.97	0.91	1.07
Norquay + Pitic 62	4	0.82	--	0.79	--	0.86	--	0.98	--	0.83	--	0.97
+ Glenlea	0.42**	0.87	0.77	0.89	0.73	0.91	0.89**	1.02	0.44**	0.89	0.67**	0.92
+ Park	0.87	1.12	1.18	1.18	0.99	1.16	0.99	1.01	0.85	1.12	0.87	0.95

Table 6 (continued)

Mixture	RY values for measured characters ³											
	HI		Y/H		FL		Ht		ExL		HL	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
Glenlea + Pitic 62 + Park + 70M09002 + Norquay	1.00 0.94 0.99 0.97	1.08* 1.07 1.02 1.11**	1.08 1.07 1.10 1.14	1.01 1.00 0.98 0.86	0.96 0.94 0.95 0.96	1.03 0.07 1.03 0.89	1.01 1.01 1.02 1.04	1.04 0.97 1.03 0.93	1.13 1.15 1.17* 1.20*	1.03 0.97 1.02 0.98	1.08 1.07 1.09 1.05	0.98 1.00 0.99 0.96
Park + Pitic 62 + Glenlea + 70M09002 + Norquay	1.05 1.00 0.98 1.01	1.09 0.98 1.03 0.99	1.17 0.91 0.95 1.24	0.92 0.70** 0.88 0.96	0.98 0.97 0.92 0.96	1.00 0.96 0.95 1.01	1.04 1.02 0.98 1.02	0.96 0.93 0.94 0.99	1.11 1.08 1.08 1.11	0.90 0.89 0.92 0.96	0.97 1.01 1.01 1.12	0.87 0.84* 0.92 0.94
70M09002 + Glenlea + Park	1.01 1.00	1.06 1.03	0.78** 0.89	0.83* 0.95	0.99 1.02	0.98 0.97	0.88 0.95	0.98 0.99	0.84* 0.90	1.01 1.05	0.88 0.99	1.08 1.11
Norquay + Pitic 62 + Glenlea + Park	-- 0.96 0.96	0.99 0.99 0.99	-- 0.60** 0.86	0.93 0.94 0.94	-- 0.90 1.04	1.00 1.01 0.97	-- 0.88 1.00	1.00 0.98 0.98	-- 0.87 0.95	0.99 1.04 0.99	-- 0.88 0.92	0.98 1.00 0.98

1. RY = character in mixture
 2. -- = character in monoculture, see Section 6.2.

3. * significant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$.

4. Character abbreviations defined in Table 1. HL = Head length.

5. No data available.

kernel weight. At the 9 cm spacing, harvest index of Glenlea in two mixtures was significantly higher than in monoculture.

With one exception, Park yielded less in mixture than in monoculture. Reduction in yield was associated with a lesser number of heads per plant, and in one mixture with fewer kernels per head.

Data for 70M009002 were only obtained for two mixture combinations. Yield in combination with Glenlea was less than in monoculture at both spacings and was associated with a reduced number of kernels per head. The number of heads per plant did not show any change from the number in monoculture. Park did not significantly reduce the yield of 70M009002.

Data for Norquay in association with Pitic 62 were only available for the 9 cm spacing. Although yield was less than in monoculture, none of the RY values were significantly less than 1. At the 3 cm spacing, the performance of Norquay in the presence of Glenlea was poor, and the number of kernels per head and 1000 kernel weight were both significantly ($\alpha \leq 0.01$) reduced. RY for the number of heads per plant was, in spite of its low value (0.72), not significantly less than 1, due to the small number of observations for this treatment. Association with Park reduced the yield of Norquay at the 3 cm spacing and increased yield at the 9 cm spacing, but neither value (0.87 and 1.12) was significant.

Overall, Glenlea tended to produce RY values greater than 1 for plant weight, yield and components of yield, while values less than 1 were more frequent among the other genotypes. This suggests that Glenlea plants grown in mixture were able to utilise a greater amount of resources than when grown in monoculture. The other genotypes, in particular Park, were more often negatively affected by associated genotypes.

Relative yield totals, derived from the RY values, appeared to be close to 1 for most cases (Appendix 9). A graphic representation of the performance of plants grown in monoculture and in mixture further illustrates the effects of mixture components on each other. Figures 2a through 2e illustrate the relationship between the yields of the genotypes grown in binary mixtures, and their yields in monoculture. In these graphs the monocultures and mixtures are seen as a 'replacement series' (de Wit, 1960), with the proportions of the genotypes in mixture being 1:0, 0.5:0.5 and 0:1, respectively.

At the 9 cm spacing, the RYT of the mixtures Glenlea+Pitic 62 and Glenlea+Norquay was greater than 1, and in both cases, the mixture yield surpassed the yield of the better component grown in monoculture.

At the 3 cm spacing, none of the RYT values were greater than 1, suggesting a detrimental effect of genotype interaction on plant yield at this spacing.

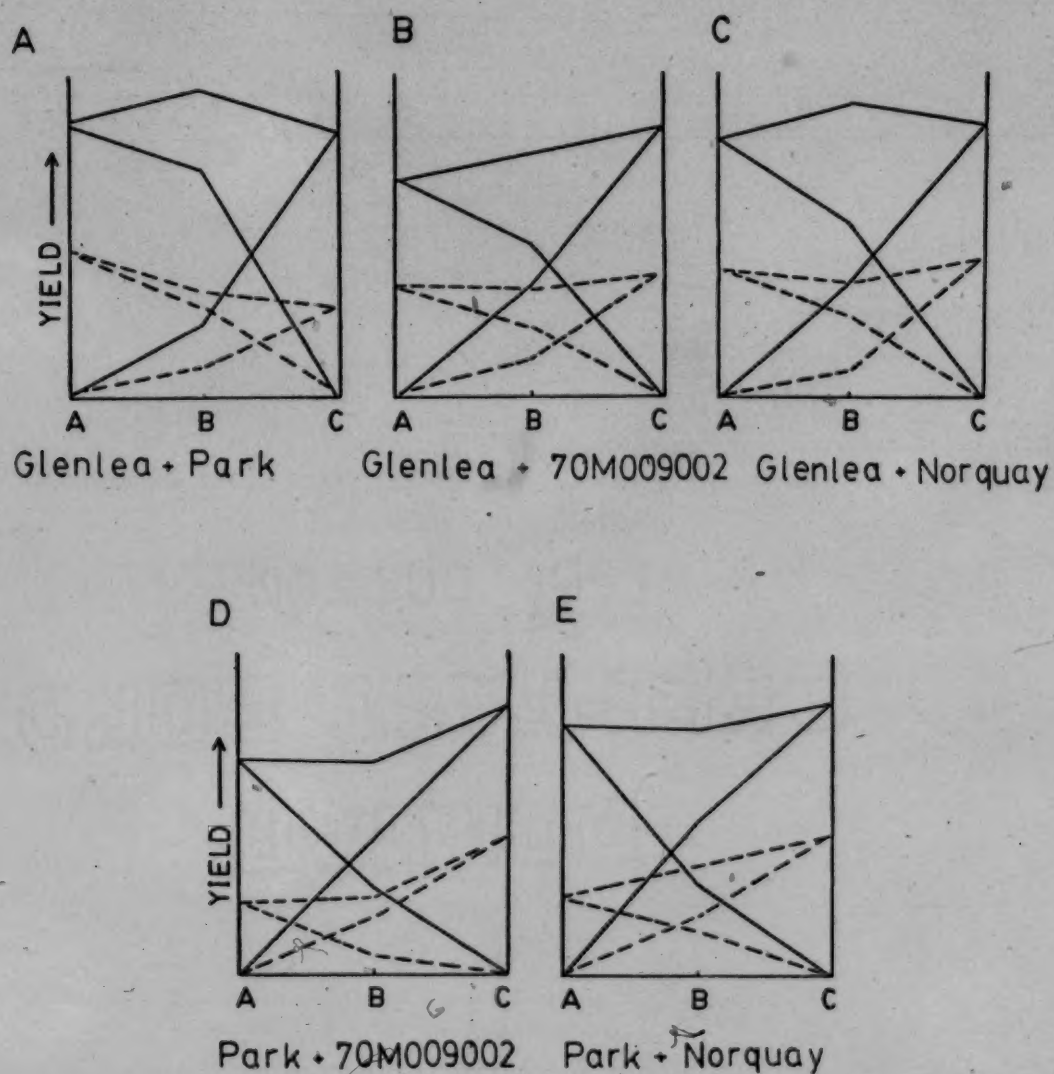


Fig. 2a-e. Graphic illustration of the genotype interaction effects on genotype and mixture yield in five genotype mixtures, each grown at two different interplant spacings in 1978. Along the X-axis, the populations containing 100% of the first genotype, 50% of each genotype, and 100% of the second genotype, are marked with the letters A, B and C, respectively.

6.3.4 Relationships between characters of interacting genotypes

One of the objectives of this study was to investigate the relationship between the measured values of characters on neighbouring genotypes. Correlations were therefore computed between the plant characters of each genotype in the test, and a number of characters of the associated genotypes (Table 7).

For most genotypes, the characters which played a role in plant interaction at the 3 cm and at the 9 cm spacings were not the same. Only Pitic 62 showed negative relationships of several characters with height of its associates at both spacings. In addition, the neighbour characters by which a genotype was affected differed from genotype to genotype.

Most characters of Pitic 62 were negatively correlated with the height of its associates. Since Pitic 62 was the latest maturing genotype in the test, and could throughout the growing season be identified in the field through its slow development, it is possible that this genotype showed more clearly the effects of interaction with taller neighbours, affecting plant weight, as well as grain yield and its components.

At the 3 cm spacing, most characters of Glenlea were positively associated with the weight and/or yield and the harvest index of its associates. Only tiller number was negatively related to the height of the associated

Table 7. Correlations¹ of single plant characters of five genotypes, with characters of associated mixture components, at two interplant spacings.

All plants were grown in four-row plots in 1978. The data pairs were averages of randomly selected plants, which had both neighbours present, and which were measured at maturity.

Char- acter ²		Characters of associated mixture components with which correlations occurred				
		Inter- plant spacing (cm)	Pittic 62	Glenlea	Park	Norquay
T	3	FL**	T*, H*	FL*, Ht*	III**	FL**, Ht*
H	3	FL**, Ht*	T*, H*	T*	III*	FL**, Ht*
Wt	3	FL**, Ht*	T*	Wt*, Y*		FL*, Ht*
Y	3	FL**, Ht*	T*	Wt*, Y*		FL*
K/P	3	FL**, Ht*		Wt*, Y*		FL*, Ht*, ExL*
Kot	3	FL*		III*		FL*, Ht*
K/H	3	FL*		Wt*, Y*, Ht*		FL*, Ht*, ExL*
III	3	Y**, Wt**		Wt*, Y*, Ht*		FL*, Ht*, ExL*
FL	3	FL*		Wt*, Y*, Ht*		FL*, Ht*, ExL*
Ht	3	FL*		Wt*, Y*, Ht*		FL*, Ht*, ExL*
HL	3	Y*, Wt*		Wt*, Y*, Ht*		FL*, Ht*, ExL*
ExL	3	FL**, Ht*		Wt*		FL*, Ht*, ExL*
Y/H	3	FL**, Ht*		Wt*		FL*, Ht*, ExL*
T	9	Ht*		Ht*		HL*
H	9	FL*, Ht*, ExL*		Wt*, Y*		HL*
Wt	9	FL*, Ht*, ExL*		Wt*, Y*		HL*
Y	9	FL*, Ht*, ExL*		Wt*, Y*		HL*
K/P	9	FL*, Ht*		FL*		T*, H*
Kot	9	III*		FL*		ExL*
K/H	9	T*		FL*		ExL*
III	9	FL**, Ht*		Y*		T*, H*, Wt*, Y*
FL	9	ExL*		Y*		T*, H*, Wt*, Y*
Ht	9	FL**, Ht*		Y*		ExL*
HL	9	FL**, Ht*		Y*		ExL*
ExL	9	FL**, Ht*		Y*		ExL*
Y/H	9	FL**, Ht*		Y*		ExL*

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1. HL = Head length.

3. - negative correlations, + positive correlations.

genotypes. At the 9 cm spacing, however, weight, 1000 kernel weight, height and extrusion length of Glenlea were negatively correlated with yield, weight and harvest index of associated genotypes. It was earlier shown (Table 6), that Glenlea yielded better in most mixture situations than in monoculture. This could occur either if the demands of associates were less than those of Glenlea, leaving the latter a larger share of the available resources, or through 'hogging' of resources by Glenlea, resulting in suppression of the associated genotypes, accompanied by reductions in yield. RY values of less than 1, for the genotypes which were grown in combination with Glenlea (Table 6), support the latter hypothesis.

Park showed very few significant correlations at either the 3 cm or the 9 cm spacing. This could mean that either Park was not much affected by genotype interaction, or that Park was affected by its associates in an inconsistent manner. Since performance of Park in mixture was typically less than its performance in monoculture (Table 6), it can be concluded that Park responded differently to the various associated genotypes.

At the 3 cm spacing, many characters of both 70M009002 and Norquay were negatively correlated with the height of their associates, as was earlier described for Pitic 62. Unlike Pitic 62, however, these relationships did not exist at the 9 cm spacing. Pitic 62, 70M009002 and Norquay all have a medium height, but Pitic 62 tends to produce more

tillers (Appendix 7). It is possible that the tillers of Pitic 62 intermingle more with the tillers of neighbouring plants than do the tillers of the two other genotypes. This could result in effects of competition for light at both interplant spacings in mixtures containing Pitic 62, while for 70M009002 and Norquay, the increase in spacing from 3 cm to 9 cm was sufficient to reduce competition for light to an insignificant level.

Overall, it appears that competition for light plays an important role in the relationships between interacting genotypes, in particular for the shorter types and at the higher plant density. However, the negative correlations between the yield components of associated genotypes which occurred at the 9 cm spacing, indicate that competition for other growth factors did occur as well.

6.3.5 Interaction between genotypes during the early stages of growth

Mean values and standard deviations for characters measured on plants, grown in monoculture, at the flowering stage and at the mid-dough stage are reported in Appendices 10 and 11.

Again, correlations between characters of associated genotypes were calculated (Table 8). Positive correlations appeared to be more common than negative ones.

At the flowering stage, however, the flag leaf area of most genotypes appeared to be negatively correlated with

Table 8. Correlations¹ of single plant characters of five genotypes, with characters of associated mixture components, in machine seeded plots, at two growth stages.

All plants were grown in four-row plots in 1978. The data pairs were averages of randomly selected tillers.

Char- acter ²	Growth stage ³	Characters of associated mixture components with which correlations occurred				
		Pitic 62 4	Glenlea	Park	70H09002	Norquay
		-	+	-	+	-
FL	F					
Ht	F		ExL**, A**			ExL*
A	F	ExL**, Ht*	A*	A*		Ht**, A*
ExL	F		ExL**	ExL**, Ht**	FL*	Ht**, A*
HL	F	FL*, Ht**	ExL*, A*		ExL*, Ht*	ExL**
FL	M					
Ht	M	ExL*		ExL*		FL*
A	M	ExL*				
ExL	M				ExL*	
HL	M	ExL*		ExL*		

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1. HL = Head length, A = Area of the flag leaf blade.

3. F = Flowering stage, M = Mid-dough stage.

4. - negative correlations, + positive correlations.

height components in associated genotypes. Variations in photosynthesis due to competition for light, or other factors correlated with height, could have affected leaf growth. This effect was not observed at the mid-dough stage, suggesting that leaf senescence, which sets in earlier in some genotypes, and in some plants within genotypes, than in others, caused a greater variation in the measurements of this character at flowering.

Plant height and height of the flag leaf of Norquay were negatively correlated with height of its associates at the flowering stage, but not at the mid-dough stage.

Overall, it appears that the effects of genotype interaction on the expression of the measured characters at both stages of growth were small. This might be partially caused by the greater amount of plant-to-plant variation which occurs in machine seeded plots than in plots with accurately spaced plants. Interaction associated with differences in height, however, appeared to occur at both stages of growth.

6.4 Discussion

6.4.1 Effects of genotype interaction on plant-to-plant variation

The variances of measurements of plants grown in monocultures and plants grown in mixtures were not

significantly different, possibly because a systematic planting pattern was used. A genotype, which is grown in a mixed stand in which two genotypes are alternated and accurately spaced within the row, will always have the same type of neighbours, even though these are different from neighbouring plants in a monoculture. This consistency in neighbour relationships may explain the observed lack in variation.

Sakai (1955) observed that a genotype which tends to dominate in a mixture shows greater variation when grown in mixture with a less dominant type, than when grown alone or in combination with another dominating type. He did not discuss any changes in variation which could occur in a mixture of genotypes with an equal ability to dominate. One could, however, expect effects on within genotype variation which are related to the relative amount of random variation present in the two genotypes. A variable genotype, in combination with a uniform genotype, could conceivably show a reduction in variation, because the environment it experiences in such a mixture is more uniform than its environment in monoculture. Similarly, the other mixture component could show an increase in variation.

Any of these situations would result in a significant genotype x mixture interaction effect on plant-to-plant variation. In the present study, however, this interaction was only significant for 1000 kernel weight (Table 3).

When observing for each genotype the combined data from several binary mixtures, however, an increase in plant-to-plant variation was found for the number of tillers, weight and yield at the 3 cm spacing, and for kernel weight at the 9 cm spacing (Table 4). These effects may well be the result of the greater amount of environmental variation which is caused by the range of genotypes in the mixtures.

At both the 3 cm and the 9 cm spacing, the distribution of several characters, in particular kernel weight and harvest index, deviated significantly from normal. Although the analysis of variance is insensitive to small deviations from normality, other conclusions based on estimates of variation might be biased to a greater extent. The effect of non-normality on the expected gain from selection in a breeding program will be discussed in Chapter 9.

Chebib et al. (1973) found that in a mixture of segregating F3 lines of wheat, the effect of interaction between genotypes on plant-to-plant variation was insignificant for all measured characters. His results might be partially explained though, by the fact that he obtained his segregating population from a cross between the genotypes Pembina and Manitou, which have a similar genetic back ground', and therefore would produce a progeny which is

 'Pembina=Thatcher x R.L.2564(R.L.2564=McMurchy-Exchange x Redman')
 Manitou=(Thatcher'-Frontana x Thatcher'-Kenya Farmer) x Thatcher'-P.I.170925

genetically and morphologically much more uniform than the progeny from a more diverse cross would be.

Kelker and Briggs (1978) reported both increases and decreases in variation as a response to interaction of several genotypes. In their experiment, seven genotypes of wheat, including the ones used in the present study, were mixed within rows, simulating a segregating population. It was concluded that the tendency to increase or decrease in variation is genotype-specific.

The number of genotypes in the present study was not large enough to be able to verify Kelker and Briggs' conclusion, although the results from the present experiment do not disagree with their results. In Kelker and Briggs' study, the variation of the genotypes Glenlea, Park and 70M009002 each increased in variation due to genotype interaction at a density of 87 plants/ m², in particular for the characters heads per plant, yield and plant weight. In addition, variation for height of Pitic 62, Glenlea, and Norquay, and harvest index of Pitic 62, Glenlea, Park and Norquay decreased. Similar effects were observed in the present study (Appendix 7).

6.4.2 Effects of genotype interaction on mean plant performance

Significant changes in the mean values of several characters, related to either total plant weight or to plant yield, were observed, as a response to genotype interaction.

Harvest index, which is the ratio of plant weight and plant yield, was very little affected, illustrating the stability which a complex character can maintain in spite of the plasticity of its components.

For some genotypes, the response to genotype interaction was quite different at 3 cm and at 9 cm spacing. This was demonstrated most clearly by Glenlea, the characters of which showed positive correlations with most characters of neighbours at the 3 cm spacing, while negative correlations were more prevalent at the 9 cm spacing. Thus, a change in interplant relationships occurred with increasing plant spacing. A possible explanation is that at the 3 cm spacing, the available growth factors were limiting to both genotypes in the mixtures, thus preventing the expression of genotypic differences. At the 9 cm spacing, resources were less limiting and plants would have a greater chance to develop according to their genetic potential. This could have resulted in negative relationships between the measured characters of Glenlea and its associates at the 9 cm but not at the 3 cm spacing. this hypothesis is supported by the observation in 1977, that effects of genotype interaction were insignificant at the highest plant density, where all plants were severely reduced in growth.

Competitive interaction between plants frequently leads to negative correlations between characters of the genotypes combined in a mixture. However, positive correlations are observed as well. Interaction between plants of different

oat species, resulting in positive correlations between the height of mixture components, has been described by Trenbath and Harper (1973).

Factors which cause differences between replicates, such as soil heterogeneity or a difference in elevation, could also be the cause of a positive correlation between characters of genotypes which are combined in a mixture. In the present study, however, it was not possible to distinguish between positive correlations due to plant interaction and those due to other factors.

There is some evidence in the literature (Troughton and Whittington, 1968), that maturity is positively correlated with root mass, because late flowering plants can invest more time in the development of an extensive root system. If maturity is positively correlated with root mass, then Pitic and Glenlea, which were the latest maturing genotypes in this study, could have had a competitive advantage through a larger root system. This could cause negative correlations of other characters specific to these genotypes, such as the number of tillers or height, with the yield components of their associates. Whether this was the case can only be confirmed through studies involving measurements on the root systems during the growing season. This hypothesis could also explain why Park, which was the earliest genotype in the study, generally performed poorly in mixture.

At the 9 cm spacing, negative correlations existed between kernel weight and the number of tillers and the

number of heads on neighbours. These relationships suggest a different type of interaction than observed at the 3 cm spacing. Although interactions related to the greater nutrient requirements of plants with more tillers are probably of importance, one has also to consider the effect which variation in the number of tillers could have on the competition for light between neighbouring plants. It is possible that at the lower plant density, plants with many tillers interfere more with the light reception of their neighbors than do plants with less tillers, resulting in the observed correlations.

Interaction between genotypes in a mixture occurs throughout most of the growing season. In addition to measurements at maturity, a detailed study of the growth and development of each mixture component could therefore provide information on the causal basis for the observed results of interaction. Several studies have indicated that differences in the developmental pattern of neighbouring plants greatly influence their interaction (Christian and Gray, 1941; Trenbath and Harper, 1973; Trenbath, 1975; Harper, 1977; Clark, 1980). The present study was not designed to perform such a detailed growth analysis. However, data collected at different times during the summer suggest that interactions occurring before flowering, and specifically those affecting growth of the flag leaf, may ultimately affect grain filling through an altered photosynthetic area (Hsu and Walton, 1971)

7. Effects of Seed Size on Plant Interaction

7.1 Materials and methods

In 1979, seed of the genotypes Pitic 62, Glenlea, Park, Norquay, and 70M009002 was sorted, through sieving and hand picking, into large, medium, and small size seeds (Appendix 12). The medium size seeds were discarded, and the rest seeded in plots, containing only large seeds, only small seeds, or small and large seeds alternated within the rows.

All seeds were glued onto strings (see Section 5.1.2) with 3 cm between seeds. The plots each consisted of three 2.5 m long rows, 30 cm apart, and all treatments were replicated three times. Eighteen adjacent plants (54 cm) from the middle rows were sampled at the 3-5 leaf stage, at the jointing stage, at the heading stage and at maturity. Since sampling at each time was completed in one day, the five genotypes were not at exactly the same stage of development.

The locations of the samples were randomised within each row, and two plants at the end of each sample were allowed as guards. At the time of sampling, all plants in the section of row to be harvested were numbered, and measurements were taken on each plant. Empty places in the row were recorded and plants with one or both first neighbours missing were discarded.

The characters which were measured varied with the time of sampling, as indicated in Table 9, and were chosen, for each developmental stage, as features which could easily be distinguished.

7.2 Analysis of the data

The data were analysed to investigate the effects of seed size and uniformity on plant performance, on within genotype variation, and on the interaction between neighbouring plants.

Variance, skewness and kurtosis of the measured characters were computed for each sample. The effects of genotype, seed size and uniformity on these parameters were examined for each sample date with an analysis of variance. Because several of the distributions of measured characters deviated significantly from normality, a natural log transformation of the variances was used (see Section 6.2)

Because plants were missing at the end of some rows, it was very difficult to identify the exact sequence number of each plant. This especially created a problem in the plots with mixed seed. It was, therefore, impossible to compare the performance of plants from large and small seeds in mixture, with the performance of the same type of plants in plots from uniform seed.

Differences between the genotypes, between the replicates, and between the performance of plants from

Table 9. Plant characters which were measured or derived at four stages of growth in 1979.

Measured Character	Abbreviation	Growth Stage ¹			
		1	2	3	4
Height (to tip of longest leaf) (cm)	Ht ₁	x			
Height (of top most node) (cm)	Ht ₂		x		
Height (to tip of head, including awns) (cm)	Ht ₃			x	
Number of leaves	L	x			
Number of nodes	N		x		
Dry weight (g)	Wt	x	x	x	x
Number of tillers	T	x	x	x	x
Number of heads	H				x
Height of flag leaf (cm)	FL				x
Number of spikelets/head	Sp/H				x
Yield/plant (g)	Y				x
Number of kernels/plant	K/P				x

Derived Character	Abbreviation	Growth Stage ¹			
		1	2	3	4
Harvest Index = Yield (g)/Dry Weight (g)	HI				x
1000 kernel weight = Yield (g)/Number of kernels x 1000 (g)	Kwt				x
Number of kernels/head = Number of kernels/Number of heads	K/H				x
Extrusion length = Height - height of flag leaf (cm)	ExL				x

1. 3-5 leaf stage
2. jointing stage
3. heading stage
4. maturity

large, small, and mixed seed were examined, for each sample date, with an analysis of variance.

To investigate the interactions between adjacent plants from small, large, or mixed seed, simple correlation coefficients were computed for all character combinations on pairs of neighbouring plants (1st with 2nd, 2nd with 3rd, etc.).

It was intended to compute these correlations for second neighbours as well as for first neighbours. Missing plants, however, severely reduced the number of pairs for which correlations could be computed. For every plant which was missing, four of the first neighbour pairs and five of the second neighbour pairs were invalidated, or 23.5% and 31.3% respectively of the data. Since an average of 1.8 plants per plot were missing (10%), correlations on second neighbours have not been included.

In 1978, it was noticed that considerable variation in height existed among plants of the line 70M009002. At the end of the 1979 growing season, it became apparent that this genotype was not a pure line. There was a marked variation in height and awn length, and it was decided to eliminate this line from all tests involving single plant data. No meaningful comparisons concerning plant interactions can be made between treatments if there are already genetic differences in plant form, and possibly growth pattern, within the line under investigation. It is now believed that this line possessed a degree of outcrossing, perhaps as high

as 5%, which would explain the increase in heterogeneity as seed was increased during the three years of this study (Dr. K. G. Briggs, Professor of Plant Breeding, University of Alberta, Edmonton, Alberta, 1980, personal communication).

7.3 Results

7.3.1 Effects of seed size on mean plant performance and sample distribution of characters

Mean values of the plants from small seeds, from large seeds, and from mixed seeds, at each of the measured growth stages are shown in Appendices 13-16. Values of skewness and kurtosis of the samples are given in Appendix 17.

At the 3-5 leaf stage the plants from mixed seed had a significantly lower variance ($\alpha \leq 0.05$) for number of leaves than the plants from the uniform seed (Table 10). At maturity, only the variance of head length was significantly ($\alpha \leq 0.05$) affected by seed treatment. The head length of plants from small seed was much more variable than was the head length of plants from large or mixed seed.

The skewness and kurtosis of the characters within sample dates were not significantly affected by the treatments. However, distributions did differ significantly among growth stages for those characters which could be compared: the number of tillers, weight and height (sample 3, 4 only, Table 11). Kurtosis of all three characters was

Table 10. The effect of genotype and seed treatment¹ on the variance² of single plant characters, at different stages of growth, as determined by analyses of variance³.

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters ⁴	
		Number of leaves at the 3-5 leaf stage	Head length at maturity
Genotype (G)	3	9591	13978
Seed treatment (S)	2	15672*	24183*
Replicate (R)	2	667	14899
G × S	6	4458	6429
G × R	6	11539	7085
S × R	4	5445	7661
Residual	12	3729	6127

1. Seeds were sorted into large and small seeds (see Appendix 10) and seeded in rows with uniformly large seeds (treatment 1), uniformly small seeds (treatment 2), or large and small seeds alternated (treatment 3).
2. The natural logarithm of the variances was used.
3. * significant, $\alpha \leq 0.05$.
4. Characters which showed no significant differences have been excluded.

Table 11. The effect of growth stage, genotype, and seed treatment¹ on the variance² and skewness of single plant characters, as determined by analyses of variance³.

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of distribution parameters				
		Variance			Skewness	
		Ht ⁴	T	Wt	Ht	T
Growth stage (GS)	3	12.48**	25.68**	554.14**	3.26	5.14*
Genotype (G)	3	2.03**	4.80**	1.23	0.36	2.16*
Seed treatment (S)	2	0.11	0.68	1.87	1.08	0.29
Replication (R)	2	0.26	0.72	0.82	0.10	1.04
GS × G	9	2.51**	1.07	3.13	0.33	0.66
GS × S	6	0.76	0.53	1.82	1.55	1.05
GS × R	6	0.26	0.29	0.59	2.60	0.72
G × S	6	0.57	0.44	1.49	1.62	0.24
G × R	6	1.07	0.40	1.74	0.35	1.93
S × R	4	0.51	0.56	4.39*	1.68	0.76
Residual	12	0.47	0.57	1.71	0.85	0.79

1. As defined in Table 10.

2. The natural logarithm of the variances was used.

3. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

4. Character abbreviations defined in Table 1.

unaffected by growth stage, as was skewness of the weight distribution. However, the skewness of the distribution of tiller number changed significantly ($\alpha \leq 0.01$) from an, on the average, negative value at the first three sample dates, to a positive one at maturity (Appendix 17).

The skewness of the height distribution increased from an average value of -0.34 at the heading stage, to a value of -0.69 during the last part of the growing season (Appendix 8). Although the difference has only a significance level of $\alpha = 0.057$ it does illustrate the increase in skewness which was earlier observed by Koyama and Kira (1956).

At each growth stage, differences among genotypes were significant for most characters (Table 12a through d). At the first three growth stages, the genotype x treatment interactions were more often significant than were the treatment effects. This suggests that genotypes were affected differently by the various seed treatments throughout the growing season. At maturity, the seed treatment main effects and the genotype x seed treatment interactions were predominantly insignificant, as were the seed treatment effects. Height and dry weight, which had shown significant seed treatment effects at the jointing and at the heading stage, did not show these effects any longer. Because maximum height was not obtained by most plants until after heading, this disappearance of seed treatment effects illustrates the tendency of plants to grow out to a uniform

Table 12a. The effect of genotype and seed treatment¹ on single plant characters, measured at the 3-5 leaf stage, as determined by analyses of variance.²

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters ³			
		Ht ₁	L	T	Wt (x 10 ³)
Genotypes (G)	3	322**	0.28	8.31**	5**
Seed treatment (S)	2	10	0.82	0.97	3
Replicates (R)	2	47**	4.46**	0.68	2
G × S	6	23	2.16**	2.77**	3*
G × R	6	58	1.39**	1.45	4**
S × R	4	1	6.87**	1.47	1
G × S × R	12	31	2.02**	1.74**	3*
Residual	392	12	0.32	0.70	1

1. As defined in Table 10.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 9.

Table 12b. The effect of genotype and seed treatment¹ on single plant characters, measured at the jointing stage, as determined by analysis of variance.²

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters ³			
		Ht ₂	N	T	Wt
Genotypes (G)	3	147**	11.21**	12.29	3.24**
Seed treatment (S)	2	61*	0.26	6.99	0.58
Replicates (R)	2	78**	12.03**	3.39	1.74**
G × S	6	51**	2.03**	4.56	0.62*
G × R	6	36*	0.84	7.42	0.44
S × R	4	116**	2.05**	5.55	0.38
G × S × R	11	63**	2.12**	3.77	0.46
Residual	315	17	0.45	4.90	0.28

1. As defined in Table 10.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 9.

Table 12c. The effect of genotype and seed treatment¹ on single plant characters, measured at the heading stage, as determined by analyses of variance.²

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters ³		
		Ht ₃	T	Wt
Genotypes	3	18462**	68.7**	1.69
Seed treatment	2	200**	0.7	9.63*
Replicates	2	187**	12.7*	2.08
G × S	6	270**	13.0**	9.77**
G × R	6	45	7.5	3.34
S × R	4	283**	6.1	7.07*
G × S × R	12	134**	7.5*	3.57
Residuals	383	28	4.0	2.67

1. As defined in Table 10.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 9.

Table 12d. The effect of genotype and seed treatment¹ on single plant characters, measured at maturity, as determined by analysis of variance².

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters ³						
		Ht ₃	T	H	Wt	Y	K/P(x 10 ⁻²)	HI(x 10 ³)
Genotypes	(G) 3	15437**	73.9**	55.1**	1297**	339.6**	2156**	73**
Seed treatment (S)	2	34	11.7*	9.4*	48	10.7	145	3
Replicates (R)	2	51	14.1*	14.6**	58	10.4	145	1
G x S	6	66	5.0	4.6	85	20.6*	153*	3
G x R	6	17	5.5	5.2	84	12.9	77	7**
S x R	4	42	11.4**	4.6	28	4.8	55	4
G x S x R	12	69	10.4**	7.2**	100*	10.3	84	7**
Residual	404	59	3.4	2.9	50	40.6	58	2

Source of variation	df	Mean squares of characters						
		Kwt	K/H	F1	ExL	Sp/H	HL	
Genotypes (G)	3	4557.6**	3582**	8409**	5606**	11.2**	508.1**	
Seed treatment (S)	2	42.9**	43	30	10	0.4	0.6	
Replicates (R)	2	115.2**	184*	38	25	11.6**	0.7	
G × S	6	7.1	94	94	15	1.1	3.7	
G × R	6	19.5*	44	46	11	4.4*	16.9**	
S × R	4	13.0	55	6	15	3.1	7.3*	
G × S × R	12	15.6*	103*	71	4	2.1	8.4**	
Residual	404	8.9	56	47	17	1.7	3.0	

1 As defined in Table 10.

2 * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3 Character abbreviations defined in Table 9.

height, which is characteristic of their genotype.

The mean tiller number per plant dropped from jointing to maturity, for all genotypes except Park (Appendices 14 through 16). Tiller number was not significantly affected by seed treatment at the jointing and the heading stages, a significant genotype x seed treatment interaction ($\alpha \leq 0.01$) occurred at the heading stage, and at maturity, a significant treatment effect ($\alpha \leq 0.05$) existed for the number of tillers and the number of heads per plant (Table 12b through d).

At maturity, the plants from small seeds had fewer tillers and heads than did the plants from large seeds, for all genotypes except Glenlea (Appendix 16). Since seed treatment effects earlier in the season were not significant, this suggests that plants from small seed on the average lost more tillers than did plants from large seeds. Thousand kernel weight of the plants from large seeds was significantly smaller ($\alpha \leq 0.01$) than that of the plants from small seeds (Table 12d).

7.3.2 Effects of seed size on interaction between neighbours

The correlations of all measured characters of each plant with those of their first neighbours gave an unwieldy total of 1572 correlation coefficients. It would be of little value to look at the magnitude of each of these coefficients individually. More important is to see if any patterns in character relations exist. If no correlation

exists between two characters of neighbouring plants, the probability that the coefficients for all four genotypes in a treatment will be of the same sign just by chance is $1 \times 1/2 \times 1/2 \times 1/2 = 0.125$. Therefore, the value of the coefficients does not have to be very high to be meaningful, if they all have the same sign. In order to accept the hypothesis that a correlation exists between characters measured on neighbouring plants, in each of the four genotypes given the same treatment, with $\alpha \leq 0.01$, each of the coefficients has to have the same sign and a significance level less than or equal to 0.47, since $2 \times (0.47)^4 = 0.01$. Using this value, all correlation coefficients were examined for each of the three treatments (Table 13).

Throughout development, positive correlations were more common than negative ones. As was explained in Section 6.4.2, plant interactions as well as environmental conditions can be responsible for this. Conditions which affect a short section of row, such as variation in depth of sowing, wheel compaction or irregular nutrient distribution, could result in higher or lower values for all plants in that section, compared with plants in the rest of the plot, and, thus, result in positive correlations between neighbours.

At the jointing stage, the only negative correlation was the one between tiller number and the number of nodes of neighbouring plants, derived from mixed seed sizes.

Table 13. Correlated¹ characters of neighbouring plants, at different stages of growth, in rows of plants from large seeds, small seeds or alternated large and small seeds.

All plants were grown in three-row plots in 1979. The data are from overlapping pairs of neighbouring plants in a row: 1st+2nd, 2nd+3rd, 3rd+4th, etc.

Growth ¹		Correlated (+, -)		
stage	Character ³	characters of neighbouring plants ⁴		
3-5L	Ht ₁	+Ht ₁ 2,	+Ht ₁ 3	
3-5L	L	+Ht ₁ 3,	+L1,	+L3
3-5L	Wt	+Ht ₁ 3		
J	Ht ₂	+Ht ₂ 1,	+Ht ₂ 2	
J	N	+Ht ₂ 1,	+N1,	+N3
J	T	+N1,	-N3,	+T1
J	Wt	+Ht ₂ 2,	+N2	
H	Ht ₃	+Ht ₃ 1,	+Ht ₃ 2	+Ht ₃ 3
H	T	+T2,	-T3	
H	Wt	+Ht ₃ 1,	+Ht ₃ 2,	+Wt2
M	Ht ₃	-KWt ₃		
M	T	-HI1,	-KWt1	
M	H	-HI1,	-KWt1	
M	K/H	-KWt1		
M	HI	+HI1		
M	KWt	+KWt1		

1. All correlations are significant with $\alpha \leq 0.01$.
2. 3-5L = 3-5 Leaf stage, J = Jointing stage, H = Heading Stage,
M = Maturity.
3. Character abbreviations defined in Table 9.
4. Last number indicates seed treatment as defined in Table 10.

At the heading stage, the tiller numbers of neighbouring plants, derived from mixed seed, were negatively correlated. However, at this stage, tiller number of some genotypes was affected by seed treatment also (Table 12c), and the observed correlation, therefore, does not necessarily imply the occurrence of neighbour interactions. At maturity, a significant negative correlation existed between the number of tillers and harvest index and between number of heads and harvest index of plants from large seeds, and between height and 1000 kernel weight, and between stem length and 1000 kernel weight, of plants from mixed seed. Since seed size effects on tiller number, head number and kernel weight were observed in plots seeded to uniformly sized seed, one would expect negative correlations between these characters, in plots from mixed seed sizes. Their absence indicates possible effects of neighbour interaction. For plants derived from small seeds, significant correlations were all positive.

7.4 Discussion

The drop in tiller number, which was observed after heading for plants from all seed treatments, was more severe for plants from small seed than for those from mixed or large seed. This resulted in significantly fewer tillers and fewer heads on plants from small seeds at maturity.

For most genotypes, however, yield per plant was not significantly affected by seed treatment. The larger 1000 kernel weight, observed for plants derived from small seeds, demonstrates compensation for the reduction in head number, through an increase in seed weight. A number of factors could have contributed to this result. Firstly, some of the assimilates which were acquired before anthesis, and which had been stored in the lost tillers may have been relocated and later been used in grain filling on the remaining tillers (Evans and Wardlaw, 1976). Secondly, since competition for light takes place between leaves rather than between plants (Donald, 1961), leaves of plants with few tillers could experience less competitive interference from leaves on other tillers than would leaves on plants with many tillers, given the same interplant spacing. A higher rate of photosynthesis per leaf could therefore occur in plants with few tillers, resulting in more assimilates per tiller and, thus, the potential for larger kernels.

The data from this test give only partial support to the findings of Hozumi et al. (1955), who found negative correlations between dry weights and between shoot lengths of neighbouring corn plants derived from uniform seed. Negative correlations did occur in the present experiment, but not very frequently. The negative correlations which were observed among plants from large seed, all occurred between tillers or heads per plant and those characters which pertain to grain filling (harvest index, 1000 kernel

weight). This suggests that variation in tiller number is, directly or indirectly, related to the process of grainfilling in adjacent plants. No negative correlations showed up in the plots from small seed. This could possibly be the result of smaller root systems, which would reduce interaction between neighbouring plants.

Although alternating height differences between neighbours existed throughout the growing season in all three treatments, at maturity only the mixed seed treatment showed significant effects related to differences in height. It was not possible to determine with certainty whether small seeds gave rise to short or tall plants. If one assumes the former, than seed size in the mixed seed treatment had an effect on kernel weight opposite to the effect observed in the uniform seed treatments. The negative correlation, which occurred in the mixed seed treatment between height and kernel weight, suggests that plants from small seed with tall neighbours yielded seeds with low kernel weight and vice versa. Thus, interaction between the tall and short plants affected plant growth in such a way that tall plants were able to acquire a relatively greater amount of one or more of the factors limiting to grain filling. It thus appears that interactions between neighbours derived from different size seeds, were different than those which occurred between plants from uniform seeds, affecting in particular the character kernel weight.

The results of the present experiment indicate that differences in seed size can be a source of variation among phenotypes, both through effects on plant development as well as through effects on neighbour relationships. Although these conclusions are based on observations in monocultures, similar effects can be expected in a mixture of genotypes. Effects of interaction between genotypes in a segregating population might thus be confounded with the effects of seed size which occurred among the seeds of the propagated lines.

8. The Relationship Between Mixture Yield and Monoculture Yield of the Components.

8.1 Materials and methods

Yield trials were grown in 1977 and 1979 in Edmonton, and in 1978 in Ellerslie. The trials involved eight genotypes (see Section 4.2), grown in monoculture and in all possible binary combinations, arranged in a randomised block design with three replications.

Plots consisted of four 6 m long rows, spaced 23 cm apart, in banks which were separated by 2 m wide pathways. The rows were seeded in all three years in a N-S direction, guard plots were seeded at the end of each bank, and at harvest, a 30 cm strip at both ends of each plot was removed. Only the center two rows of each plot were harvested with a small plot harvester'. Using a visual assesment of maturity, each plot was harvested when more than 50% of the plants appeared to be ripe.

To obtain an equal number of plants of each genotype per plot, percent germination and 1000 kernel weight of each genotype were used to calculate the weight of seed necessary to give an average density of 257 seeds/m², or an average of 1.7 cm between seeds within rows. For an average weight of 40 g/1000 kernels, this seeding rate is equivalent to 100 kg viable seed per ha. These are similar seeding rates and

'Designed and produced by J. Fitzsimmons and T. Snider,
Dept. of Genetics, University of Alberta, Edmonton, Alberta.

plant spacings to those normally used for standard yield trials of wheat at both stations.

The plots were seeded with a small-plot disk seeder, designed in 1970 by the Canadian Department of Agriculture, Swift Current, Saskatchewan. A cone-shaped seed divider was attached to partition the seed equally into the four drill rows.

Harvesting conditions in 1978 were very wet, causing some loss of yield and considerable lodging in one corner of the field. Because the amount of loss was hard to estimate, the data have not been adjusted. None of the genotypes was infested with significant levels of disease or insect pests in any of the three years.

8.2 Analysis of the data

It was the objective of this study, to observe the stability of mixture yield over years, and to investigate the relationship between mixture yield and the yield of their components grown in monoculture.

By means of a randomised block analysis of variance, the variation among years, among monocultures, among mixtures and between mixtures and monocultures was examined.

From the yields of the monocultures in each block (replicate), the expected yield of each mixture in the same block was calculated as:

$$Y(AB)=Y(A)+Y(B)/2$$

where $Y(AB)$, $Y(A)$ and $Y(B)$ are the plot yields of the mixture of genotypes A and B, and their monocultures, respectively. The ratio of the observed yield and the expected yield of a mixture of two genotypes, hereafter referred to as Specific Mixture Efficiency (SME), was calculated as:

using the same notation as above. If, for example, a mixture of the genotypes A and B has a plot yield of 1400 g, and the monoculture plot yields of A and B are 1000 g and 1500 g, respectively, then the SME of the mixture AB would be $2 \times 1400 / (1000 + 1500) = 1.12$.

The SME resembles the RYT which was used in Chapter 6. The RYT, however, is calculated from the RY of each of the components, and hence, will have values which are numerically slightly different from the SME values. The meaning of values less than one, greater than one, and equal to 1 is the same for both, however.

Significance of the SME values was tested with a t-test analogous to the one described for RYT (see Section 6.2).

Spearman's rank order correlation coefficients were computed for the correlations between grain yield of the mixtures and SME in each of the three years, as well as for the correlations between yields in 1977 and 1978, yields in 1977 and 1979, and yields in 1978 and 1979, respectively. The same correlations were computed for the SME values.

Mixtures of two genotypes can be seen as analogues of the F1 generation of a genetic cross, and hence, techniques similar to those which are used to determine genetic parameters, can be used to analyse mixture properties. An analysis of variance for diallel crosses was developed by Hayman (1954). In his method, the total variation is partitioned into a component due to 'arrays' (columns of the diallel table), a set of three orthogonal interaction components, and an error term. Morley Jones (1965) described the use of this technique to analyse data from a half diallel.

Hayman's technique of diallel analysis has been modified and used by various authors to analyse competition experiments (Williams, 1962; Eberhart et al., 1964). In most of those cases, the competing individuals could be readily identified, allowing data to be collected from each of the components of the mixtures. Hay (1974) described the use of Hayman's analysis of variance for experiments in which the competing individuals cannot be separated.

The components of variation in the Hayman analysis are:

1. The array sum of squares, with $n-1$ degrees of freedom for an $n \times n$ diallel. Each column of the full diallel table comprises an array. The examination of the arrays of a half diallel thus requires that each data point is used twice in the computation. Morley Jones (1965) computed the SS for arrays as follows:

where Y_r is the sum of the r th array and Y_{rr} is the value of the r th monoculture (diagonal values of the diallel table). Significant differences among the arrays would indicate that differences exist between the general ability of the genotypes to perform in a mixture.

2. An interaction term, b , which can be partitioned into three orthogonal components:
 - a. b_1 tests the effect of genotype interaction and allows examination of the difference between mixtures and monocultures, with 1 degree of freedom.
 - b. b_2 tests the differences between genotypes in their interaction with all other genotypes. The sums of squares are computed using for each array the differences between twice the mixture values and the monoculture values:

Using the same notation as above, b_2 has $n-1$ degrees of freedom. If no interactions between genotypes occur, this component measures strictly the differences in yielding ability among genotypes.

- c. b_3 tests the effect due to specific combinations of genotypes and is computed by subtraction of the SS's for arrays for b_1 and b_2 from the total SS.

The formula which was used by Morley Jones for array SS, was used by Griffing (1956) to test differences in General Combining Ability (GCA). He used the remaining variation as a whole, to determine effects of specific combining ability (SCA). The use of Griffing's technique for the analysis of mixture experiments was suggested by Jensen and Federer (1965). Hayman's partitioning of the interaction SS, however, allows a closer examination of the types of interaction which take place and of their relative magnitude.

GCA is a parameter which was originally introduced to assess the value of a genotype for breeding purposes. An extensive review of this subject was given by Sprague and Tatum (1942). Because high yield is an objective of most breeding programs, an indicator of both yielding ability of a genotype and its value as a parent in crosses, is useful for the selection of breeding material. In experiments which study the mechanisms underlying mixture efficiency, however, the yield of a mixture is only of interest in relation to the monoculture yields of its components. Average Mixture Efficiency (AME) can be expressed as the ratio of the observed mixture yields to the mixture yields which can be expected based on the monoculture yields of the mixture components:

using the same notation as before. If, for example, binary

mixtures are formed from the genotypes A,B, and C, and the monoculture plot yields are 900 g, 950 g, and 1000 g, respectively, and the mixture plot yields are 1000 g each, the AME for genotype A would be $2 \times 3000 / (3 \times 900 + 900 + 950 + 1000) = 1.09$.

The AME provides a measure of the average effect of a genotype on mixture yield, using its monoculture yield as a point of reference. The GCA gives an indication of a genotype's ability to perform in mixture using the experiment mean as a point of reference.

Jinks (1954) suggested the use of regression of the covariances (W) of offspring and parents of a diallel cross on the variances (V) of the offspring, to investigate dominance relationships. Harper (1965) and Hill and Shimamoto (1973) used a similar technique to determine the genotypic differences in 'competitive ability' of plants grown in mixtures. For the analysis of mixture experiments, the positions of the array variances along the X-axis of the resulting graph indicate the ability of the genotypes to dominate in the mixture. Dominating types will influence the performance of the mixtures in which they grow to a larger extent than will less dominating types, resulting in more uniform array components. Their arrays are, therefore, expected to have smaller variances and covariances. As a result these values will lie near the origin of the graph. Without any specific interactions between genotypes, a regression line can be fitted with a slope of approximately

1. Deviations from 1 will result from mixtures which perform much better or much worse than expected, causing an increase in variance and a decrease in covariance.

If a linear relationship exists between V and W , the sum ($W + V$) can be correlated with the monoculture yields (or any other character that might play a role in genotype interaction) to determine whether there is an association of monoculture yield with the ability to dominate in a mixture.

For the analysis of variance of the mixture yield trials from 1977, 1978 and 1979, Hay's directions (1974) were followed. Regression lines of W on V were fitted according to Jink's method (Jinks, 1954). SME and AME values were computed, and for comparison, Griffing's (1956) formula was used to compute the effects of General and Specific Combining Ability (GCA and SCA) for each genotype or genotype combination. In order to assess the significance of the AME values, a t -test was used to compare the observed mixture yield with the expected yield based on monoculture values. Significance of the GCA values was tested with an F -test, using MS values obtained from the analysis of variance. Correlations between monoculture yields and AME were computed, to investigate the relationship between AME and yielding ability.

8.3 Results

In spite of satisfactory performance in the 1977 germination test (84.7%), Pitic 62 failed to germinate in the field that year, and in 1977, all plots involving this genotype had to be discarded.

Monoculture and mixture yields varied substantially in the three years (Appendix 18a through c). Besides the different locations involved, the weather patterns in the three years were quite dissimilar (Appendix 1), which probably contributed to these yield differences.

The yield levels of the mixtures, in relation to those of the component monocultures, were divided into the following four categories (Table 14):

1. below the monoculture yield of the lower yielding component in that year (C1),
2. between the monoculture yield of C1 and the mean of the component monoculture yields (C2),
3. between C2 and the monoculture yield of the higher yielding component (C3), and
4. above C3.

Significantly ($\alpha \leq 0.05$) more than half of the mixtures yielded more than the mid-component yield, suggesting, on the average, a greater efficiency of resource utilisation by mixtures than by monocultures in these three years. However, only 4 of the mixtures (14.3%) yielded more than the mid component yield in all three years. None yielded consistently less.

Table 14. Frequency distribution of mixture yield relative to the yield of the components grown in monoculture.

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Mixture	Frequency distribution of mixture yield ¹			
	$Y_M < C_1$	$C_1 < Y_M < C_2$	$C_2 < Y_M < C_3$	$Y_M > C_3$
Pitic 62 + Glenlea				2
Pitic 62 + Park			1	1
Pitic 62 + Neepawa			1	1
Pitic 62 + 70M110001				2
Pitic 62 + 70M009002				2
Pitic 62 + Norquay	1			1
Pitic 62 + NB 701				2
Glenlea + Park			1	2
Glenlea + Neepawa			2	1
Glenlea + 70M110001		2		1
Glenlea + 70M009002		1		2
Glenlea + Norquay			2	1
Glenlea + NB 701	2			1
Park + Neepawa	1		1	1
Park + 70M110001	1	1	1	
Park + 70M009002	1		2	
Park + Norquay		1	1	1
Park + NB 701	1		1	1
Neepawa + 70M110001	1	1	1	
Neepawa + 70M009002		1	2	
Neepawa + Norquay	1	1		1
Neepawa + NB 701		1		2
70M110001 + 70M009002	1	1	1	
70M110001 + Norquay		2		1
70M110001 + NB 701	1		2	
70M009002 + Norquay		2		1
70M009002 + NB 701		2	1	
Norquay + NB 701			1	2
	11	16	21	29
Percent of total	(14.3)	(20.8)	(27.3)	(37.7)

1. Number of seasons in which the mixture yield (Y_M) fell in the specified categories; where

C_1 = Lower yielding component

C_2 = Mid-component yield

C_3 = Higher yielding component

2. Data for Pitic 62 were only obtained in two years.

8.3.1 Effects of genotype interaction on plot yields

An analysis of variance of the combined data of the three test years showed that year effects as well as effects among mixtures and monocultures were significant ($\alpha \leq 0.01$) (Table 15). Partitioning of the treatment SS into components containing variation due to differences among monocultures, due to differences among mixtures and due to differences between mixtures and monocultures, revealed that mixture and monoculture yields did not differ significantly when observed for a period of three years. Significant interaction effects existed between years and mixtures and between years and monocultures, suggesting a year effect on the performance of individual genotypes when compared in mixture and in monoculture.

Analysis of each year individually (Table 16) revealed the absence of significant differences between monocultures in 1978. This fact is probably largely responsible for the year effect reported in Table 16. The wet fall weather in 1978 caused considerable lodging in one corner of the field, which resulted in a significant ($\alpha \leq 0.01$) replication effect, and probably obscured true genotype effects. The differences among mixture yields were significant in each of the three years ($\alpha \leq 0.05$, $\alpha \leq 0.01$, $\alpha \leq 0.01$). Only in 1977 did mixture and monoculture yields differ significantly ($\alpha \leq 0.05$).

Table 15. The effect of year, genotype monoculture and genotype mixing on plot yield, as determined by analysis of variance.¹

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Source of variation	df	Mean square
Years (Y)	2	2913881**
Treatments (T)	27 ²	26432**
Genotype		
Monocultures (Mono)	6	51901**
Mixtures (Mix)	20	18963*
Mix vs Mono	1	22990
Y × T	54	33183**
Y × Mono	12	45503**
Y × Mix	40	30069**
Y × Mix vs Mono	2	21547
Residual	168	11487

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Data for Pitic 62 have been excluded for all years.

Table 16. The effect of genotype monoculture and genotype mixing on plot yield in each of three test years, as determined by analyses of variance.¹

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Year	Source of variation	df	Mean square
1977	Treatments:		
	Genotype		
	Monocultures (Mono)	6	68725**
	Mixtures (Mix)	20	21543*
	Mono vs Mix	1	60896*
	Replications	2	22021
	Residual	53	10846
1978	Treatments:		
	Genotype		
	Monocultures (Mono)	7	22197
	Mixtures (Mix)	27	29860**
	Mono vs Mix	1	6513
	Replications	2	138430**
	Residual	107	12336
1979	Treatments:		
	Genotype		
	Monocultures (Mono)	7	48808**
	Mixtures (Mix)	27	43720**
	Mono vs Mix	1	14597
	Replications	2	3242
	Residual	107	8682

1. * significant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$.

8.3.2 Mixture efficiency and its correlation with yield

Both the mean mixture yields and SME values differed from year to year. For example, the Park/Neepawa mixture yielded well above the expected yield in 1977, while in 1979, the yield of the same combination failed to reach even the level of the lower yielding component (Appendix 18a through c).

Spearman's rank-order correlation coefficients were computed for the following correlations (Table 17):

1. mixture yield and SME in 1977, in 1978 and in 1979,
2. mixture yields in 1977 and 1978, in 1977 and 1979, and in 1978 and 1979, and
3. SME's in 1977 and 1978, in 1977 and 1979, and in 1978 and 1979.

No consistent relationship seemed to exist between the mixture yields and the SME values in any of the three years. The relative mixture yields in 1978 appeared to be quite different from those in 1977 and in 1979, and either climatic conditions or the different location could have influenced relative yields.

Attinaw (1977) grew seven of the eight genotypes which were involved in this study, at three different locations, including Edmonton and Ellerslie. Table 18 shows the rank order for yield, in each year, for the genotypes grown in his study and in this study at the two locations. Some genotypes appeared quite consistent in their relative position (e.g. Glenlea and Park), while others were more

Table 17. Relationship between mixture yield and Specific Mixture Efficiency¹, within and between years, as expressed by Spearmans rank order correlation coefficient².

Correlated Parameters ³	Correlation coefficient
$Y_{77} - Y_{78}$	-0.37*
$Y_{77} - Y_{79}$	0.58**
$Y_{78} - Y_{79}$	-0.29
$Y_{77} - \text{SME}_{77}$	0.19
$Y_{78} - \text{SME}_{78}$	0.26
$Y_{79} - \text{SME}_{79}$	0.74**
$\text{SME}_{77} - \text{SME}_{78}$	-0.21
$\text{SME}_{77} - \text{SME}_{79}$	0.29
$\text{SME}_{78} - \text{SME}_{79}$	0.06

1. As defined in Section 8.2.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Y_{77} , Y_{78} , Y_{79} = mixture yield in 1977, 1978 and 1979, respectively.

SME_{77} , SME_{78} , SME_{79} = Specific Mixture Efficiency in 1977, 1978 and 1979, respectively.

Table 18. Rank orders of the monoculture yields of eight genotypes, and the mean yields of their mixtures, as observed at the Edmonton and Ellerslie locations.

Genotype	Rank orders							
	Monocultures				Mixtures			
	1975 ¹ Edmonton	1977 ¹ Edmonton	1979 ² Edmonton	1975 ¹ Ellerslie	1978 ² Ellerslie	1977 ² Edmonton	1978 ² Ellerslie	1979 ² Edmonton
Pitic 62	1	3	1	1	5	--	4	1
Glenlea	4	4	3	3	4	5	2	3/4
Park	7	7	8	7	7	6	7	7
Neepawa	5	6	6	5	1	7	1	8
70M110001	2	3	5	2	2	3	3	5
70M009002	3	1	4	6	8	1	8	2
Norquay	6	2	7	4	3	2	5	6
NB 701	--	5	2	--	6	4	6	3/4

1. Data from Attinaw (1977)

2. Data from present study

3. Genotype not represented in test of that year

unstable (e.g. 70M009002). In 1978, however, the genotypes Neepawa and Pitic 62 showed quite a different relative yield level than in any of the other years. This erratic behaviour also determined the performance of the mixtures containing these two genotypes, as illustrated by the ranking of the array means. The variable yields obtained from both monocultures and mixtures over the three years thus appear to relate to factors other than the change in location.

8.3.3 Diallel analysis of variance

As was discussed in Section 8.2, analysis of the data as a mixture diallel allows a more detailed interpretation of the results.

Array means differed significantly in each of the three years ($\alpha \leq 0.01$) (Table 19). In the absence of interaction effects between the genotypes, this is a reflection of genotype differences in yielding ability. In the previous section it was shown, however, that in 1978, the differences among genotypes in monoculture were insignificant. A significant array effect in this year, thus, suggests the occurrence of a significant interaction between genotypes in mixture in that year.

The b1 effect, which contrasts mixture and monoculture yields, was significant in 1977 only ($\alpha \leq 0.05$), indicating that interaction between genotypes was present in that year also. Only in 1979 was the b2 effect significant ($\alpha \leq 0.01$), indicating that the effects of genotype interaction on yield

Table 19. The average array and specific effects of genotype on mixture yield, as determined by diallel analyses of variance¹ for each of the three test years.

All plots were machine seeded, and harvested at maturity.

Year	Source of variation ²	df	Mean square
1977	Replications	2	22021
	Arrays	6	100804**
	Mixtures vs monocultures	1	60896*
	Average genotype interaction	6	7519
	Specific genotype interaction	14	13805
	Residual	53	10846
1978	Replications	2	138430**
	Arrays	7	176335**
	Mixtures vs monocultures	1	6513
	Average genotype interactions	7	6901
	Specific genotype interaction	20	18877
	Residual	70	12336
1979	Replications	2	3242
	Arrays	7	168180**
	Mixtures vs monocultures	1	14597
	Average genotype interaction	7	27834**
	Specific genotype interaction	20	7501
	Residual	70	8682

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Sources of variation were partitioned according to the technique described by Hayman (1954); see Section 8.2.

differed among genotypes.

Hay (1974) explained that, when the additions made by the interactions to the array values (mixtures) are correlated with the diagonal values (monocultures), '...the differences between the arrays will be inflated and the array mean square will be more likely to reveal interactions than the b2 mean square.' It can be noted, though, that this is only the case if the correlation is positive. In the present study, the correlation between monoculture yield and Specific Mixture Efficiency was insignificant in two of the three years, and significantly positive ($\alpha \leq 0.01$) in the third year (Table 17). Simmonds (1962), however, investigated the relationship between the difference between mixture yield and mean monoculture yield, and the mean monoculture yield of the components, and reported a negative correlation. Thus, a positive correlation cannot be considered to be a general rule.

The b3 effect, which measures variation due to specific mixtures, was not significant in any of the three years, suggesting that no specific combination of genotypes performed exceptionally well or exceptionally poorly in any of the three years.

8.3.4 Mixture efficiency

The AME values for each of the genotypes in each of the three years show the ability of each genotype to perform in a mixture situation (Appendix 19). The values for GCA, which

merely reflect the relative yield level of the mixtures in the test, were computed for comparison. Slight discrepancies between the rank order for array mean yield and for GCA are due to the fact that monoculture yields are used twice in the computation of GCA and once in the computation of the array mean yield.

Great variation existed from year to year among AME values of each genotype. In 1977, all genotypes had AME values greater than 1, suggesting a contribution to the mixture yield which is greater than expected from monoculture values. In 1978, however, less than half the genotypes seemed to perform better than expected in mixture.

Correlation coefficients of AME with monoculture yield for the three years were insignificant (Table 20), and it can be concluded that no consistent relationship existed between monoculture yield and the ability to perform in a mixture.

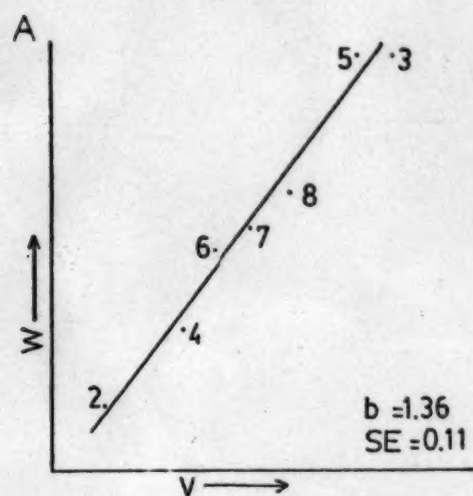
8.3.5 Regression of W on V

The regression of the covariances (W) of the array values and monoculture values (diagonal values of the diallel table) on the array variances (V), provides information on the relative ability of the genotypes to dominate in mixture (Figure 3). Because the genotype Pitic 62 was eliminated from the 1977 tests, the values for that year are not directly comparable with the other years.

Table 20. Simple correlations (r) between monoculture yield and Average Mixture Efficiency¹, in 1977, 1978 and 1979.

Year ²	r
1977	-0.48
1978	-0.05
1979	0.57

1. See Section 8.2
2. Seven genotypes were used in 1977, eight in each of the years 1978 and 1979.



- 1 Pitic 62
- 2 Glenlea
- 3 Park
- 4 Neepawa
- 5 70M110001
- 6 70M009002
- 7 Norquay
- 8 NB 701

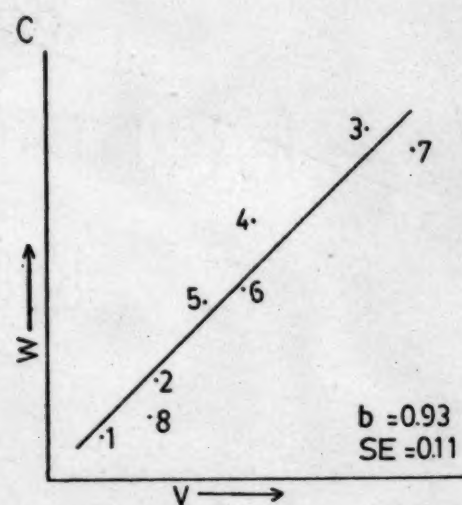
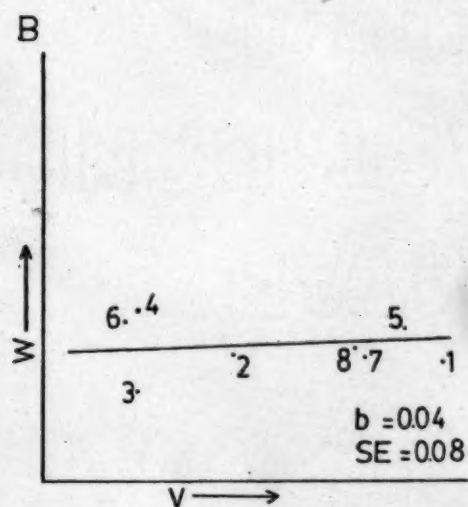


Fig. 3a-c. V-W regression lines, illustrating the relative ability of genotypes to dominate in a mixture, in the years 1977, 1978 and 1979. V = variance of the array (mixture) values, W = covariance of the array values and the diagonal (monoculture) values.

As was already shown by the previous analyses, in 1978 the behaviour of the mixtures was erratic. Although the slopes of the regression lines in 1977 and 1979 were both close to one, the ranking of the genotypes according to their behaviour in mixture was quite different in each of the years. Glenlea, 70M009002, Neepawa and Park generally maintained their positions, while 70M110001, Norquay and NB701 showed quite different behaviours in mixture in the two years.

The V-W regression line shows along the x-axis the genotypes in order of their dominance in the mixtures. Correlation of the rank-order of dominance in mixture of the genotypes with their monoculture yields, resulted in a Spearman's rank-order correlation coefficient of 0.25 (n.s.) for 1977 and of 0.99 (sign $\alpha \leq 0.001$) for 1979 (Figure 3).

It can thus be concluded that the ability to dominate in a mixture was highly variable from year to year and not consistently related to yield in monoculture.

8.4 Discussion

It has been suggested that the ability to perform well in a mixture is negatively correlated to yield in monoculture (Wiebe et al., 1961; Simmonds, 1962). The present study, however, did not support this theory. Significant differences existed in every year in the relative ability of the genotypes to dominate in mixture. No

relationship was found between the ability to dominate in mixture and monoculture yield in the same year.

Baker (1977) reported variable results for Neepawa, Pitic 62, and a mixture of the two, and ascribed this to the fact that Pitic 62 was better able to compensate for poor survival after early drought conditions, when grown in pure culture than when grown in combination with Neepawa.

DePauw et al. (1981) included the same genotypes in a study comparing yield at five locations over four years. They also found great variation in the performance of the genotype Pitic 62. They ascribed this to frost damage in the post-anthesis stage. In the present study, however, neither post-anthesis frost nor early drought occurred in any of the three years.

It is probable that the different responses of the genotypes to the variable climatic conditions were responsible for the year to year variation. Identification of genotype-specific responses to the environment, however, would require a qualitative study of genotype-environment interactions.

The results of this experiment do support the findings of those investigators who concluded that mixtures, on the average, yield more than the expected mean of the component monocultures (Table 14). This suggests that a positive interaction can occur between the components of a mixture, resulting in a more efficient use of available resources by one or both of the mixture components. Variation within and

between years, however, was so large that the yield advantage of mixtures over monocultures was statistically insignificant (Table 15). No specific binary mixture was identified which consistently gave a high yield advantage.

9. Discussion of the Results with Respect to Single Plant Selection in Early Generations

Inefficiency of single plant selection in early generations can be ascribed to two major sources of error:

1. The amount of additive genetic variation present in the population is low, which makes it difficult to identify those genotypes which harbour the superior genetic material one wishes to select.
2. Effects of genotype x environment interaction on plant growth can cause undesirable phenotypic variation.

The relative magnitude of these factors is expressed by the heritability (H^2) of a character, which is computed as follows:

$$H^2 = \text{Genetic variance} / \text{Total variance}$$

Estimates of heritability can be obtained in a variety of ways, and the outcome will vary with the experimental design used and the method of computation employed (Allard, 1960; Falconer, 1960). Experiments with a large number of replications will reduce the environmental variance and, thus, give higher estimates for H^2 . However, single plant selections from early generations have to be made from unreplicated plots, and the improvement of the selected population over the parental population depends entirely on how accurately superior genotypes can be identified within those plots.

9.1 Effects of non-normal character distribution on single plant selection

The expected gain from selection can be expressed as

where k is the selection differential, which takes into account the mean and the variance of the parental population, the mean of the selected fraction, and the selection intensity; σ is the phenotypic standard deviation; and H^2 is the heritability of the observed character (Allard, 1960). This expression assumes a normal distribution of the units to be selected, whether they are mean values of characters of plants grown in rows or observations on single plants. Reports on non-normal distributions of several characters of various plant species were given by Koyama and Kira (1956) and by Harper (1977).

The present study showed that the genotypes grown in binary mixtures with a range of associated genotypes at the 3 cm spacing, showed significant deviations from normality for all characters, except the number of kernels per head and height of the flag leaf (Appendix 8). At the 9 cm spacing, deviations from normality occurred for the number of tillers, the number of heads, kernels per plant, 1000 kernel weight and harvest index.

Deviations from normality will affect the accuracy with which genotypes can be distinguished, and will lead to gains from selection which are different than those expected based on the above formula.

The effect which a positively skewed distribution would have on single plant selection is graphically illustrated in Figure 4a. If genotypes with a high value of a certain character are to be selected, a positive skewness would increase the probability for less desirable genotypes to be present in the selected fraction. Similarly, a negative skewness (or selection of plants with the lowest values for a certain character from a population with a positively skewed distribution) would result in a selected fraction with more desirable genotypes than would have been the case if the character had been normally distributed.

To quantify this effect, the distribution of chi-square, which is a typical skewed distribution, can be conveniently used (Appendix 20). It has been shown, that the effect of skewness on single plant selection became much larger when the frequency of superior genotypes in the population was low. (Dr. D. H. Kelker, Associate Professor of Statistics, University of Alberta, Edmonton, Alberta, 1981, Personal communication). A positive skewness would, thus, result in gains from selection which are much lower than expected, based on estimates of heritability. Similarly, a negative skewness would result in a higher than expected gain from selection, if the highest values from the population were selected.

Considering these facts, Appendix 8 leads to the conclusion that response to selection at the 3 cm spacing would be less than expected for the number of tillers, the

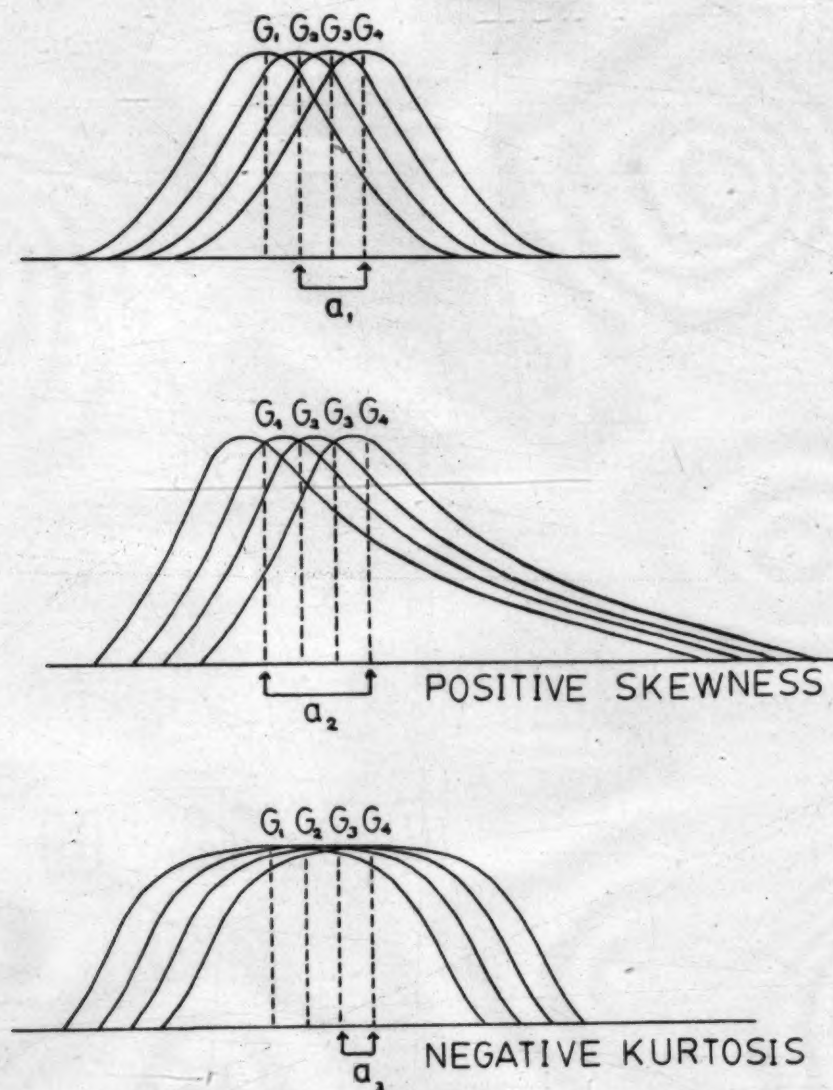


Fig. 4. The effect of skewness and kurtosis of the distribution of a plant character on single plant selection. $G_1 - G_4$ represent genotypes in a mixture, with means at equal distances apart. a_1, a_2 and a_3 are the ranges of genotypes selected in populations with a normal distribution, a positive skewness, and a positive kurtosis, respectively. $a_3 < a_1 < a_2$.

number of heads, weight, yield and kernels per plant, and greater than expected for 1000 kernel weight, harvest index, height and extrusion length, provided that the tallest individuals were selected.

As was mentioned earlier, little can be said about the effect of a significant kurtosis in the presence of skewness. In the absence of skewness, however, a positive kurtosis is likely to have an adverse effect on selection (Figure 4b), because the selected fraction would be contaminated with less desirable genotypes to a greater extent than would be the case if the character had been normally distributed. Similarly, better results can be expected with a negative kurtosis.

At the 9 cm spacing, selection for a large number of tillers or a large number of kernels per head could result in smaller than expected gains, while selection of plants with a high harvest index or large kernels could result in a higher than expected gain.

9.2 Effects of genotype interaction on single plant selection

The results from the experiment conducted in 1978 suggest that within-genotype variation of several characters would be significantly increased by genotype interaction if the plants were grown in a multi-component mixture. At the 3 cm spacing, the number of tillers, weight and yield

were affected by genotype interaction, while at the 9 cm spacing, 1000 kernel weight showed an increase in variation (Table 4).

The effect of genotype interaction on estimates of heritability is shown in Tables 21a and 21b for the data from the experiment grown in 1978. Analyses of variance for each interplant spacing, using a random model (Steel and Torrie, 1980), provided the variance components which were used to estimate the values of H^2 (Briggs et al, 1978). Differences between the two estimates suggest that genotype interaction can lead to higher estimates of heritability, in particular for the characters weight, yield and kernels per plant. This observation supports the idea that H^2 is not always a reliable predictor for the ease with which a character can be improved through selection.

9.3 Effects of interplant spacing on single plant selection

The within-genotype variation for several characters of plants grown in monoculture increased significantly with an increase in spacing (Table 4). The mean variation of the four genotypes, when grown in mixture, increased significantly with the increase in spacing for all characters, except kernels per head and components of height.

This suggests that identification of superior genotypes would be more successful at the 3 cm than at the 9 cm

Table 21a. Estimates of heritability of single plant characters, grown at a 3 cm interplant spacing, as computed from monoculture and mixture data of four genotypes.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character ²	Heritability	
	Computed from monoculture data	Computed from mixture data
T	0.57	0.57
H	0.66	0.70
Wt	0.16	0.50
Y	0.35	0.63
K/P	0.04	0.35
Kwt	0.91	0.94
K/H	0.70	0.83
HI	0.63	0.63
FL	0.88	0.89
Ht	0.83	0.83
ExL	0.01	0.48
HL	0.87	0.90

1. Heritability = $\frac{\text{Genetic variation}}{\text{Total variation}}$

2. Character abbreviations defined in Table 1. HL = Head length.

Table 21b. Estimates of heritability of single plant characters, grown at a 9 cm interplant spacing as computed from monoculture and mixture data of four genotypes.

All plants were grown in four row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character ²	Heritability	
	Computed from monoculture data	Computed from mixture data
T	0.0	0.0
H	0.0	0.32
Wt	0.48	0.67
Y	0.50	0.71
K/P	0.19	0.45
Kwt	0.97	0.97
K/H	0.71	0.77
HI	0.71	0.71
FL	0.91	0.91
Ht	0.74	0.74
ExL	0.78	0.87
HL	0.87	0.94

1. Heritability = $\frac{\text{Genetic variation}}{\text{Total variation}}$

2. Character abbreviations defined in Table 1. HL = Head length.

spacing, because the genetic variance at the 3 cm spacing and at the the 9 cm spacing is approximately the same, differing only by an amount representing genotype x spacing interaction.

Other studies led to different conclusions, however. In an earlier study concerning the same genotypes as were used in the present experiment, a decrease rather than an increase in variation with an increase in spacing was observed for most characters (Kelker and Briggs, 1978). The different results may be partially explained by the fact that in the present study, the difference between the two seeding rates was much larger than in the earlier study. In addition, the distance between rows was larger in the present experiment than in the previous study, resulting in a different spatial arrangement of the plants, which would cause different neighbour interactions (Harper, 1961; Donald, 1963). It is unlikely, though, that these factors can account for a complete reversal of the effect of an increase in spacing on plant-to-plant variation.

Nass (1980) observed that, while biological yield and grain yield of plants from two spring wheat crosses responded each in a different manner to a ten-fold increase in plant spacing, harvest index of plants from both crosses was less variable at a higher (commercial) plant density. Nass recommended growing plants at commercial crop densities, if plants with high harvest index were to be selected. The commercial seeding rate for the humid Prince

Edward Island environment, however, is more than double the rate used in Alberta.

The fact that different seeding rates as well as different planting patterns were used in the various studies, makes it difficult to compare their results. It can be concluded, though, that an increase in plant spacing does not always result in an increase in plant-to-plant variation. The contrasting results from the two Alberta studies, concerning the same genotypes, suggest that location effects and year effects may play an important role.

The present study showed that mean values of most characters were significantly affected by spacing effects as well as by genotype x spacing interaction effects (Table 5). This could lead to different results from selection at different spacings (CIMMYT, 1972; Nass, 1980). For this reason, as well as to avoid a possible increase in variation, selection should be practiced at a density which approximates the commercial seeding rate of the region to which the selected genotypes have to be adapted.

9.4 Effects of seed size on single plant selection

The experiments performed to evaluate the effect of variation in initial seed size on plant-to-plant variation, suggested that variation in seed size can be an additional source of error in the identification of superior genotypes.

The number of heads, the number of tillers and 1000 kernel weight appeared to vary with initial seed size, while harvest index and 1000 kernel weight were affected by variations in seed size among neighbouring plants. Thus, the use of uniform seed would reduce the plant-to-plant variation observed in the selection plots.

This has earlier been suggested by Christian and Gray (1941) and by Chebib et al. (1973). However, the sorting of seed should aim for seed of medium size, to avoid selection for large kernelweight. The latter could be an undesirable side effect, because the number of kernels per head and 1000 kernel weight are negatively correlated (Fischer, 1975 ;Jenner, 1979). Reports of studies investigating the effects of selection for increased kernel size on yield are contradictory (Bhatt and Derera, 1973; Rasmusson and Cannell, 1970), while the percent protein in the kernels tends to decline with an increase in kernel size (Röbbelen, 1979). The merits of seeding uniform seed would, therefore, have to be evaluated for each selection program in light of its breeding objectives.

9.5 Suitability of various characters for single plant selection

The formula for the calculation of heritability shows that the highest values will be obtained for characters which:

- a show a large amount of additive genetic variation, and
 - b are little affected by random environmental variation.
- The previous sections of this chapter explained that, in addition, the best chances for genetic improvement through selection exist for those characters which, in a segregating population grown at a commercial crop density:
- c are little affected by variations in initial seed size,
 - d are little affected by neighbour interactions arising from variations in seed size,
 - e are little affected by genotype interactions, and
 - f have a distribution which is negatively skewed (if the lowest values are to be selected the skewness should be positive).

For most characters, there are one or more factors by which selection is hindered. Estimates of heritability would encompass the factors mentioned in the points a, b, c and d. To what extent H^2 is biased through genotype interaction effects would depend on the method of calculation (Hamblin and Rosielle, 1978). The effects of non-normality are not accounted for.

Because only homozygous genotypes were used in this study, there is only additive genetic variation, and a hypothetical mixture of these genotypes would be unrepresentative of a segregating population. But the characters measured in this study can be evaluated with respect to the remaining points which determine the efficiency of selection. It then appears that the characters

1000 kernel weight and harvest index did fulfill these requirements best (Tables 4, 5, 12d), and gains from selection could be higher than suggested by an estimate of heritability. Based on the data from this study, the number of tillers, the number of heads and yield can be expected to respond poorly to single plant selection, resulting in less genetic improvement than expected. Of the remaining characters, none had a distribution which would interfere with predictions of gain from selection. Genotype interaction, however, biased estimates of heritability for plant weight, yield and kernels per plant.

It was explained that kernel weight is not always a reliable indicator of yield and may affect percent protein of the selected genotypes. Selection for high harvest index, as an indirect method for selection for yield, however, has shown promising results (Donald and Hamblin, 1976; Fischer and Kertesz, 1976; Bhatt, 1977). The present study gives support to the observation that selection for high harvest index can result in high gains from selection (Bhatt, 1977).

The results from the present study suggest, that, in order to evaluate the suitability of a character for selection in early generations, the distribution of this character in a multi-component mixture, as well as its sensitivity to genotype interaction, should be evaluated at a commercial plant density, in conjunction with the estimation of its heritability. The combined information

could then lead to a more realistic expectation of the progress which can be made through selection.

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Appendix 1. Mean monthly temperatures and precipitation near the test sites, for the growing seasons of 1977, 1978 and 1979, and the long term averages.

A. Edmonton

Month	Temperature (°C)			Rainfall (mm)		
	1977	1979	Long term average ¹	1977	1979	Long term average
May	11.8	8.7	10.9	134	38	37
June	15.6	14.9	14.7	11	63	75
July	15.6	17.8	17.5	107	122	83
August	13.4	16.5	15.9	91	39	72
September	9.6	12.9	10.9	40	22	36

B. Ellerslie

Month	Temperature (°C)		Rainfall (mm)	
	1978	Long term average ²	1978	Long term average
May	10.5	10.5	59	47
June	16.0	14.0	38	84
July	16.5	16.0	114	85
August	14.5	15.0	94	68
September	12.0	10.0	34	36

1 Average of 99 years. Information obtained from the Annual Meteorological Summary for the Edmonton Municipal Airport, issued by Environment Canada, 1980.

2 Average of 17 years. Information obtained from the Department of Geography, Division of Meteorology, 1980.

Appendix 2. Details regarding fertiliser and herbicide application to the 1977, 1978 and 1979 locations.

Location	Fertiliser ¹ (kg/ha)			Herbicide		
	N	P	K	Trade name ²	Growth stage	Rate of application
Edmonton 1977	14	34	0	Buctril M	3-5 leaf	237 m/ha
Ellerslie 1978	14	34	0	Avadex	N. A. ³	13.6 kg/ha
				MCPA-K	3-5 leaf	237 ml/ha
				Banvel	3-5 leaf	44 ml/ha
Edmonton 1979	5.5	14	0	Avadex	N.A.	14.2 kg/ha

1. Actual amounts N, P and K applied, derived from granular mono ammonium phosphate ($\text{NH}_4\text{K}_2\text{PO}_4$) in a broadcast application; applied two weeks before seeding and incorporated by disking.

2. Active ingredients:

Buctril M: 3,5-dibromo-4-hydroxybenzonitrile
 Avadex: S-(2,3,3-trichloroallyl) diisopropyl thiocarbamate
 MCPA-K: K-salt of 2-Methyl, 4-chlorophenoxyacetic acid
 Banvel: 2 methoxy-3,6-dichlorobenzoic acid

3. N. A. = not applicable.

Appendix 3. Agronomic characters of wheat genotypes in the study.

Genotype	Maturity ¹	Height (cm) ²	Tiller number per plant ³	1000 kernel weight (g) ⁴
Pitic 62	+6	85	4.5	36.7
Glenlea	+8	108	2.6	44.6
Neepawa	-1	101	4.5	33.4
70M110001 ⁵	0	102	No data	32.9
70M09002 ⁶	+3	91	No data	44.2
Norquay	+4	86	3.3	42.8
NB 701 ⁷	+4	82	3.4	36.6
	+1	108	No data	43.0

1. Number of days earlier or later than Neepawa (Attinaw, 1977).

2. Attinaw, 1977

3. Average of 1978, 1979 tests, plants 3 cm apart in rows 30 cm apart

4. Average of 1977, 1978, 1979 seedlots used.

5. Pedigree of 70M110001 = CIANO S × ((CIANO × SON-KL REND) 8156)

6. Pedigree of 70M00900 = CIANO S $\times$ ((SON 64-Y 50ES $\times$ G10) INIA'S')
7. Data obtained from 1976 Co-op NonBread Wheat Test, Edmonton.
Pedigree of NB701 = ((SON 64-Y 50ES $\times$ G10) INIA) $\times$ INIA'S' - NAPO

Appendix 4. Thousand kernel weight (1000 kwt) and percent germination (% germ) of the seed used for the experiments in 1977, 1978 and 1979.

Genotype	1977		1978		1979	
	1000 kwt	% germ	1000 kwt	% germ	1000 kwt	% germ
Pitic 62	34.3	84.0	39.1	99.5	No data	98.5
Glenlea	42.5	95.0	41.8	93.5	44.5	97.5
Park	33.5	96.0	31.8	99.0	34.9	98.5
Neepawa	32.1	99.0	33.2	99.0	33.5	82.5
70M110001	35.9	98.0	47.9	94.5	48.9	99.0
70M009002	33.6	92.0	48.9	100.0	45.9	99.5
Norquay	35.8	88.5	36.6	98.5	37.3	87.0
NB 701	38.9	98.0	43.1	85.0	47.1	91.0

Appendix 5. Number of plants available per treatment, from each density, for analysis of the wheelplot experiment, grown in 1977.

Genotype	Associate Genotype	Plants per treatment						
		204 ¹	124	69	44	28	17	10
Glenlea	Glenlea	11	14	13	13	15	13	8
	Neepawa	7	7	7	6	5 ₂	7	5
	70M110001	6	7	8	5	-	-	6
	70M009002	9	-	10	5	5	-	-
	NB 701	-	7	7	5	-	-	-
Park	Park	6	14	12	11	15	13	13
	Neepawa	-	5	6	-	-	-	-
	70M110001	7	8	-	-	-	-	-
	70M009002	6	7	7	8	7	6	7
	NB 701	6	7	7	9	7	7	6
Neepawa	Glenlea	7	10	7	8	6	7	6
	Park	-	7	7	-	-	-	-
	70M110001	6	-	-	-	-	-	-
	Norquay	-	-	-	-	6	7	-
	NB 701	7	6	6	9	7	6	6
70M110001	70M110001	16	10	10	11	12	8	9
	Glenlea	6	6	6	7	-	-	5
	Park	8	6	-	-	-	-	-
	Neepawa	5	-	-	-	-	-	-
	NB 701	-	-	7	9	-	-	5
70M009002	Glenlea	5	7	6	5	5	6	5
	Park	7	6	6	-	6	8	7
	NB 701	6	9	6	7	7	8	9
Norquay	Norquay	-	6	6	7	-	-	6
	Neepawa	-	-	-	-	8	7	6
	NB 701	9	6	-	-	-	-	8
NB 701	Glenlea	-	6	6	5	-	-	-
	Park	8	6	-	5	6	7	9
	Neepawa	7	7	7	7	7	7	8
	70M110001	-	-	5	6	-	-	5
	70M009002	5	5	6	8	5	5	7
	Norquay	5	8	-	-	-	5	-

1. Plant density (plants/m²)

2. Less than five plants available

Appendix 6. Descriptive statistics of characters of plants, grown in monoculture and in mixture at various interplant spacings, measured at maturity in 1977.

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FILE WP77 (CREATION DATE = 03/18/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS						
BROKEN DOWN BY		HT	CUL	PLANT HEIGHT CM				
BY		BY	SPAC	CULTIVAR				
BY		BY	COMP	INTER-PLANT SPACING				
		BY	COMP	TREATMENT				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
FOR ENTIRE POPULATION			88417.0000	93.8198	15.8889	252.4570	(1049)	
CUL	2	GLENLEA	20281.0000	111.4341	8.8044	77.8177	(182)	
SPAC	1	204 PLANTS M	2885.0000	112.2917	11.0748	122.8504	(24)	
COMP	1	MONOCULTURE	1250.0000	113.6384	8.1520	66.4545	(11)	
COMP	2	MIXTURE	1445.0000	111.1538	13.2908	178.8410	(13)	
SPAC	2	3 CM SPACING	3882.0000	113.7714	8.8828	99.8821	(35)	
COMP	1	MONOCULTURE	1856.0000	111.1429	15.0018	225.0849	(14)	
COMP	2	MIXTURE	2426.0000	115.9238	3.8810	15.0819	(21)	
SPAC	3	9 CM SPACING	3897.0000	111.3423	8.2417	68.4084	(36)	
COMP	1	MONOCULTURE	1474.0000	113.3848	3.4288	11.7584	(13)	
COMP	2	MIXTURE	2423.0000	110.1384	11.2897	127.4867	(22)	
SPAC	4	44 PLANTS M	2232.0000	111.8483	8.7447	76.4704	(28)	
COMP	1	MONOCULTURE	1482.0000	114.0000	2.5820	6.6657	(13)	
COMP	2	MIXTURE	1750.0000	109.3750	11.2778	127.1833	(18)	
SPAC	5	28 PLANTS M	2223.0000	111.1500	4.2212	17.8184	(20)	
COMP	1	MONOCULTURE	1853.0000	110.8857	3.7007	13.8982	(15)	
COMP	2	MIXTURE	880.0000	112.0000	5.9562	35.6000	(8)	
SPAC	6	17 PLANTS M	2202.0500	110.1000	5.8930	32.4105	(20)	
COMP	1	MONOCULTURE	1440.0000	110.7692	5.5995	31.3590	(13)	
COMP	2	MIXTURE	762.0000	106.8571	6.0845	37.1429	(7)	
SPAC	7	10 PLANTS M	2050.0000	107.8947	8.6210	74.3218	(19)	
COMP	1	MONOCULTURE	874.0000	108.2500	5.3385	28.5000	(8)	

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	1178.0000	108.9091	10.8495	111.2909	(11)
CUL	3.	PARK	19818.0000	95.7285	7.3821	54.0827	(207)
SPAC	1.	204 PLANTS M	2443.0000	97.7200	7.0877	50.2787	(28)
COMP	1.	MONOCULTURE	807.0000	101.1857	5.7417	32.9887	(8)
COMP	2.	MIXTURE	1838.0000	98.8318	7.2884	52.9012	(19)
SPAC	2.	3 CM SPACING	3984.0000	98.4380	9.0223	81.4024	(41)
COMP	1.	MONOCULTURE	1393.0000	98.8000	10.8484	113.3482	(14)
COMP	2.	MIXTURE	2881.0000	94.8519	7.8539	60.9603	(27)
SPAC	3.	9 CM SPACING	3188.0000	99.0000	5.0737	25.7419	(32)
COMP	1.	MONOCULTURE	1230.0000	102.5000	4.2959	18.4545	(12)
COMP	2.	MIXTURE	1938.0000	98.9000	4.3518	18.8388	(20)
SPAC	4.	44 PLANTS M	2888.0000	95.8288	8.2324	67.7728	(28)
COMP	1.	MONOCULTURE	1093.0000	98.3838	4.0810	16.6545	(11)
COMP	2.	MIXTURE	1893.0000	93.7058	9.5182	90.8958	(17)
SPAC	5.	28 PLANTS M	2818.0000	97.0890	3.7410	13.9951	(29)
COMP	1.	MONOCULTURE	1458.0000	97.2557	3.1278	9.7810	(18)
COMP	2.	MIXTURE	1358.0000	98.8871	4.4177	19.5188	(14)
SPAC	8.	17 PLANTS M	2398.0000	92.1838	8.8217	48.8284	(28)
COMP	1.	MONOCULTURE	1192.0000	91.8923	7.8418	61.3974	(12)
COMP	2.	MIXTURE	1204.0000	92.8184	9.1717	38.6887	(13)
SPAC	7.	10 PLANTS M	2354.0000	90.8388	6.1289	37.5388	(28)
COMP	1.	MONOCULTURE	1188.0000	91.1538	8.1080	37.3077	(13)
COMP	2.	MIXTURE	1166.0000	89.8231	9.3308	40.0788	(13)
CUL	4.	70MOOS002	12488.0000	95.4088	8.8524	78.3888	(131)
SPAC	1.	204 PLANTS M	1908.0000	98.4000	9.3288	88.8888	(20)
COMP	2.	MIXTURE	1908.0000	95.4000	9.3288	88.8888	(20)
SPAC	2.	3 CM SPACING	2308.0000	100.2174	10.2848	105.8887	(23)
COMP	2.	MIXTURE	2308.0000	100.2174	10.2848	105.8887	(23)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	1938.0000	98.9000	8.0518	64.8318	(20)
COMP	2.	MIXTURE	1838.0000	98.9000	8.0518	64.8318	(20)
SPAC	4.	44 PLANTS M	1818.0000	95.1788	10.8872	120.2784	(17)
COMP	2.	MIXTURE	1818.0000	95.1788	10.8872	120.2784	(17)
SPAC	5.	28 PLANTS M	1829.0000	98.2832	4.8288	23.3158	(18)
COMP	2.	MIXTURE	1829.0000	98.2832	4.8288	23.3158	(18)
SPAC	5.	17 PLANTS M	1836.0000	91.8000	8.2827	39.2211	(20)
COMP	2.	MIXTURE	1836.0000	91.8000	8.2827	39.2211	(20)
SPAC	7.	10 PLANTS M	1084.0000	88.8887	8.7330	45.3333	(12)
COMP	2.	MIXTURE	1084.0000	88.8887	8.7330	45.3333	(12)
CUL	5.	NORQUAY	10989.0000	78.1301	10.8572	117.8798	(148)
SPAC	1.	204 PLANTS M	2838.0000	78.4000	10.8578	117.8841	(35)
COMP	1.	MONOCULTURE	1213.0000	78.8128	8.7780	33.3828	(18)
COMP	2.	MIXTURE	1425.0000	75.0528	13.9802	194.8082	(18)
SPAC	2.	3 CM SPACING	1878.0000	78.3182	15.0187	225.5606	(22)
COMP	1.	MONOCULTURE	788.0000	79.8000	8.3588	57.8000	(10)
COMP	2.	MIXTURE	883.0000	73.5833	18.4680	340.9824	(12)
SPAC	3.	9 CM SPACING	1780.0000	78.0870	12.3818	152.8103	(23)
COMP	1.	MONOCULTURE	709.0000	70.8000	7.4304	55.2111	(10)
COMP	2.	MIXTURE	1041.0000	80.0789	14.1085	198.0789	(13)
SPAC	4.	44 PLANTS M	2088.0000	78.8288	10.8517	111.5489	(27)
COMP	1.	MONOCULTURE	811.0000	73.7273	8.7481	33.0182	(11)
COMP	2.	MIXTURE	1285.0000	78.8280	12.8853	180.9187	(18)
SPAC	5.	28 PLANTS M	844.0000	70.3333	4.2923	18.4242	(12)
COMP	1.	MONOCULTURE	844.0000	70.3333	4.2923	18.4242	(12)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	565.0000	70.6250	4.2405	17.8821	(8)
COMP	1.	MONOCULTURE	565.0000	70.6250	4.2405	17.8821	(8)
SPAC	7.	10 PLANTS M	1423.0000	74.8847	8.1711	66.7881	(18)
COMP	1.	MONOCULTURE	880.0000	73.3333	2.8000	8.2500	(8)
COMP	2.	MIXTURE	763.0000	78.3000	11.1081	123.3444	(10)
CUL	8.	70M000002	10194.0000	77.8188	8.2935	68.7818	(131)
SPAC	1.	204 PLANTS M	1488.0000	82.5556	11.0897	123.2028	(18)
COMP	2.	MIXTURE	1488.0000	82.5556	11.0897	123.2028	(18)
SPAC	2.	3 CM SPACING	1728.0000	78.5455	7.0287	49.4028	(22)
COMP	2.	MIXTURE	1728.0000	78.5455	7.0287	49.4028	(22)
SPAC	3.	9 CM SPACING	1447.0000	80.3889	7.2772	52.8575	(18)
COMP	2.	MIXTURE	1447.0000	80.3889	7.2772	52.8575	(18)
SPAC	4.	44 PLANTS M	988.0000	82.4187	8.8189	77.7187	(12)
COMP	2.	MIXTURE	988.0000	82.4187	8.8189	77.7187	(12)
SPAC	5.	28 PLANTS M	1314.0000	73.0000	8.4772	30.0000	(18)
COMP	2.	MIXTURE	1314.0000	73.0000	8.4772	30.0000	(18)
SPAC	8.	17 PLANTS M	1880.0000	78.4545	8.7844	48.1845	(22)
COMP	2.	MIXTURE	1880.0000	78.4545	8.7844	48.1845	(22)
SPAC	7.	10 PLANTS M	1870.0000	74.7619	7.2450	82.4905	(21)
COMP	2.	MIXTURE	1870.0000	74.7619	7.2450	82.4905	(21)
CUL	7.	NBROUAY	5371.0000	77.8408	8.4180	41.1854	(88)
SPAC	1.	204 PLANTS M	733.0000	81.4444	2.7888	7.7778	(8)
COMP	2.	MIXTURE	733.0000	81.4444	2.7888	7.7778	(8)
SPAC	2.	3 CM SPACING	883.0000	79.4187	3.3428	11.1742	(12)
COMP	1.	MONOCULTURE	473.0000	78.8333	3.2808	10.8867	(8)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	480.0000	80.0000	3.8332	13.2000	(8)
SPAC	3.	9 CM SPACING	440.0000	73.3333	5.2409	27.4667	(8)
COMP	1.	MONOCULTURE	440.0000	73.3333	5.2409	27.4667	(8)
SPAC	4.	44 PLANTS M	551.0000	78.7143	7.1581	51.2381	(7)
COMP	1.	MONOCULTURE	551.0000	78.7143	7.1581	51.2381	(7)
SPAC	5.	28 PLANTS M	588.0000	83.2500	7.9778	83.8428	(8)
COMP	2.	MIXTURE	588.0000	83.2500	7.9778	83.8428	(8)
SPAC	6.	17 PLANTS M	1141.0000	78.0867	5.2436	27.4952	(15)
COMP	2.	MIXTURE	1141.0000	78.0867	5.2436	27.4952	(15)
SPAC	7.	10 PLANTS M	687.0000	73.8167	7.3768	84.4470	(12)
COMP	1.	MONOCULTURE	448.0000	74.8333	3.8560	13.3667	(8)
COMP	2.	MIXTURE	438.0000	73.0000	10.2176	104.4000	(6)
CUL	8.	NB701	19288.0000	108.3889	8.4189	88.8567	(183)
SPAC	1.	204 PLANTS M	2782.0000	110.4800	7.4728	55.8433	(25)
COMP	2.	MIXTURE	2782.0000	110.4800	7.4728	55.8433	(25)
SPAC	2.	3 CM SPACING	3530.0000	110.3125	8.8830	81.8347	(32)
COMP	2.	MIXTURE	3530.0000	110.3125	8.8830	81.8347	(32)
SPAC	3.	9 CM SPACING	2822.0000	109.2500	6.2780	39.4130	(24)
COMP	2.	MIXTURE	2822.0000	109.2500	6.2780	39.4130	(24)
SPAC	4.	44 PLANTS M	3266.0000	108.0000	7.7889	80.2000	(31)
COMP	2.	MIXTURE	3266.0000	108.0000	7.7889	80.2000	(31)
SPAC	5.	28 PLANTS M	1886.0000	105.3333	8.9452	48.3353	(18)
COMP	2.	MIXTURE	1886.0000	105.3333	8.9452	48.3353	(18)
SPAC	6.	17 PLANTS M	2381.0000	89.2083	10.8848	113.7373	(24)
COMP	2.	MIXTURE	2381.0000	89.2083	10.8848	113.7373	(24)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	2811.0000	88.9310	8.0234	38.3808	(28)
COMP	2.	MIXTURE	2811.0000	88.9310	8.0234	38.3808	(28)
TOTAL CASES =	1080						
MISSING CASES =	31 OR	2.9 PCT.					

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FILE WP77 (CREATION DATE = 03/15/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		FL CUL		HEIGHT OF THE FLAG LEAF BLADE CM			
BY		BY		CULTIVAR			
BY		BY		INTER-PLANT SPACING			
				TREATMENT			
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			37001.0000	38.3083	7.8172	81.1088	(1048)
CUL	2.	CLENLEA	7181.0000	39.3482	8.4181	41.1888	(182)
SPAC	1.	204 PLANTS M	833.0000	38.8750	4.0358	16.2880	(24)
COMP	1.	MONOCULTURE	433.0000	38.3838	3.7785	14.2545	(11)
COMP	2.	MIXTURE	800.0000	38.4615	4.3515	18.9359	(13)
SPAC	2.	3 CM SPACING	1400.0000	40.0000	4.4721	20.0000	(35)
COMP	1.	MONOCULTURE	840.0000	38.5714	5.0340	25.3407	(14)
COMP	2.	MIXTURE	860.0000	40.9524	3.8920	15.1476	(21)
SPAC	3.	8 CM SPACING	1363.0000	38.9429	8.0844	82.5281	(35)
COMP	1.	MONOCULTURE	531.0000	40.8482	13.9454	194.4744	(13)
COMP	2.	MIXTURE	832.0000	37.8182	4.3495	18.9177	(22)
SPAC	4.	44 PLANTS M	1148.0000	39.5882	7.1840	51.3227	(29)
COMP	1.	MONOCULTURE	515.0000	39.8184	9.3858	88.0897	(13)
COMP	2.	MIXTURE	833.0000	39.5625	5.0328	25.3282	(18)
SPAC	5.	28 PLANTS M	807.0000	40.3500	7.8480	83.1888	(20)
COMP	1.	MONOCULTURE	597.0000	39.8000	8.8208	74.3143	(15)
COMP	2.	MIXTURE	210.0000	42.0000	8.9582	35.8000	(8)
SPAC	6.	17 PLANTS M	778.0000	38.8000	5.2405	27.4632	(20)
COMP	1.	MONOCULTURE	501.0000	38.8385	5.3481	28.6028	(13)
COMP	2.	MIXTURE	277.0000	39.5714	5.3807	28.9524	(7)
SPAC	7.	10 PLANTS M	732.0000	38.5283	4.5138	20.3743	(18)
COMP	1.	MONOCULTURE	307.0000	38.3750	5.2827	27.8984	(8)

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CRITERION VARIABLE PL							
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	425.0000	38.8384	4.1839	17.2545	(11)
CUL	3.	PARK	8509.0000	41.1083	5.2035	27.0780	(207)
SPAC	1.	204 PLANTS M	955.0000	39.8600	5.3343	40.1233	(25)
COMP	1.	MONOCULTURE	259.0000	42.8687	3.5024	12.2687	(8)
COMP	2.	MIXTURE	743.0000	39.1083	5.8467	48.8772	(18)
SPAC	2.	3 CM SPACING	1897.0000	41.3802	5.2148	27.1939	(41)
COMP	1.	MONOCULTURE	804.0000	43.1428	4.8882	24.8934	(14)
COMP	3.	MIXTURE	1093.0000	40.4815	5.1989	27.0285	(27)
SPAC	3.	8 CM SPACING	1318.0000	41.1250	5.4875	30.1129	(32)
COMP	1.	MONOCULTURE	530.0000	43.3333	2.2887	5.1815	(12)
COMP	2.	MIXTURE	788.0000	38.8000	5.4204	41.2211	(20)
SPAC	4.	44 PLANTS M	1177.0000	42.0387	5.1793	38.1839	(28)
COMP	1.	MONOCULTURE	488.0000	44.3538	3.8800	15.0845	(11)
COMP	2.	MIXTURE	689.0000	40.5234	5.9921	48.8897	(17)
SPAC	5.	28 PLANTS M	1281.0000	43.4828	3.8245	15.4015	(29)
COMP	1.	MONOCULTURE	850.0000	43.3333	3.8866	14.8924	(15)
COMP	2.	MIXTURE	511.0000	43.6429	4.1251	17.0185	(14)
SPAC	6.	17 PLANTS M	1051.0000	40.4231	3.8311	15.4833	(28)
COMP	1.	MONOCULTURE	532.0000	40.8231	4.2817	18.0789	(13)
COMP	2.	MIXTURE	519.0000	39.8231	3.8847	13.5789	(13)
SPAC	7.	10 PLANTS M	1008.0000	38.7882	3.8294	14.6848	(28)
COMP	1.	MONOCULTURE	512.0000	39.3846	4.7878	22.8231	(13)
COMP	2.	MIXTURE	496.0000	38.1838	2.8082	8.8077	(13)
CUL	4.	700000002	4471.0000	34.1288	5.8465	31.8530	(131)
SPAC	1.	204 PLANTS M	855.0000	34.7500	5.0320	54.5132	(20)
COMP	2.	MIXTURE	855.0000	34.7500	5.0320	54.5132	(20)
SPAC	2.	3 CM SPACING	782.0000	34.0000	4.7883	22.8091	(23)
COMP	2.	MIXTURE	782.0000	34.0000	4.7883	22.8091	(23)

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CRITERION VARIABLE PL							
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	710.0000	35.5000	5.3819	40.4737	(20)
	2.	MIXTURE	710.0000	35.5000	5.3819	40.4737	(20)
SPAC	4.	44 PLANTS M	555.0000	32.8471	5.8733	47.2428	(17)
	2.	MIXTURE	555.0000	32.8471	5.8733	47.2428	(17)
SPAC	5.	28 PLANTS M	843.0000	33.8421	4.4003	19.3628	(19)
	2.	MIXTURE	843.0000	33.8421	4.4003	19.3628	(19)
SPAC	6.	17 PLANTS M	555.0000	33.2500	3.6889	13.4805	(20)
	2.	MIXTURE	555.0000	33.2500	3.6889	13.4805	(20)
SPAC	7.	10 PLANTS M	421.0000	35.0833	3.9877	15.8015	(12)
	2.	MIXTURE	421.0000	35.0833	3.9877	15.8015	(12)
CUL	5.	NDROUAY	4488.0000	30.8379	5.2005	27.0447	(145)
	1.	204 PLANTS M	1088.0000	31.0000	4.3280	18.7059	(35)
	1.	MONOCULTURE	508.0000	31.8125	3.2087	10.2954	(16)
	2.	MIXTURE	578.0000	30.3125	5.0888	25.8725	(18)
SPAC	2.	3 CM SPACING	548.0000	29.4845	5.6814	44.8407	(22)
	1.	MONOCULTURE	308.0000	30.8000	3.8238	14.8222	(10)
COMP	2.	MIXTURE	340.0000	28.3333	5.3811	70.2424	(12)
	3.	8 CM SPACING	728.0000	31.8522	4.0987	16.7825	(23)
SPAC	1.	MONOCULTURE	314.0000	31.4000	4.3285	18.7111	(10)
	2.	MIXTURE	414.0000	31.8482	4.0793	16.8410	(13)
SPAC	4.	44 PLANTS M	808.0000	31.0000	7.0837	50.3200	(26)
	1.	MONOCULTURE	317.0000	31.7000	3.5282	12.4558	(10)
COMP	2.	MIXTURE	489.0000	30.5625	5.7099	78.8525	(16)
	5.	28 PLANTS M	358.0000	29.8333	4.6482	21.8081	(12)
SPAC	1.	MONOCULTURE	358.0000	29.8333	4.6482	21.8081	(12)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	289.0000	22.3780	4.4701	19.9821	(8)
COMP	1.	MONOCULTURE	289.0000	22.3780	4.4701	19.9821	(8)
SPAC	7.	10 PLANTS M	802.0000	21.8842	3.4488	11.8947	(18)
COMP	1.	MONOCULTURE	285.0000	21.8887	1.8028	3.2500	(9)
COMP	2.	MIXTURE	317.0000	21.7000	4.5717	20.8900	(10)
CUL	8.	70M008002	3408.0000	28.0228	5.3128	28.2228	(121)
SPAC	1.	204 PLANTS M	811.0000	28.3888	5.1488	26.4888	(18)
COMP	2.	MIXTURE	511.0000	28.3888	5.1488	26.4888	(18)
SPAC	3.	3 CM SPACING	893.0000	28.8848	4.8853	22.0488	(22)
COMP	2.	MIXTURE	893.0000	28.8848	4.8853	22.0488	(22)
SPAC	3.	8 CM SPACING	488.0000	27.1111	7.8823	62.3887	(18)
COMP	2.	MIXTURE	488.0000	27.1111	7.8823	62.3887	(18)
SPAC	4.	44 PLANTS M	304.0000	28.3333	8.3880	40.4242	(12)
COMP	2.	MIXTURE	304.0000	28.3333	8.3880	40.4242	(12)
SPAC	5.	28 PLANTS M	445.0000	24.7222	3.3821	11.8088	(18)
COMP	2.	MIXTURE	445.0000	24.7222	3.3821	11.8088	(18)
SPAC	6.	17 PLANTS M	588.0000	28.7273	4.0022	16.0173	(22)
COMP	2.	MIXTURE	588.0000	28.7273	4.0022	16.0173	(22)
SPAC	7.	10 PLANTS M	502.0000	23.8048	4.6280	21.3808	(21)
COMP	2.	MIXTURE	502.0000	23.8048	4.6280	21.3808	(21)
CUL	7.	NDROUAY	1853.0000	28.3043	4.8800	21.0878	(89)
SPAC	1.	204 PLANTS M	271.0000	30.1111	8.4807	41.8111	(9)
COMP	2.	MIXTURE	271.0000	30.1111	8.4807	41.8111	(9)
SPAC	2.	3 CM SPACING	341.0000	28.4187	5.1778	26.8108	(12)
COMP	1.	MONOCULTURE	182.0000	27.0000	2.4488	6.0000	(8)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	179.0000	28.8333	8.8402	48.1887	(8)
SPAC	3.	8 CM SPACING	182.0000	28.3333	3.8287	14.6887	(8)
COMP	1.	MONOCULTURE	182.0000	28.3333	3.8287	14.6887	(8)
SPAC	4.	44 PLANTS M	192.0000	27.4286	2.1482	4.6180	(7)
COMP	1.	MONOCULTURE	182.0000	27.4286	2.1482	4.6180	(7)
SPAC	5.	28 PLANTS M	285.0000	21.8780	4.0881	16.8884	(8)
COMP	2.	MIXTURE	285.0000	21.8780	4.0881	16.8884	(8)
SPAC	6.	17 PLANTS M	408.0000	27.2000	3.7284	13.8857	(18)
COMP	2.	MIXTURE	408.0000	27.2000	3.7284	13.8857	(18)
SPAC	7.	10 PLANTS M	234.0000	27.8333	4.0839	16.8152	(12)
COMP	1.	MONOCULTURE	171.0000	28.5000	3.8341	14.7000	(8)
COMP	2.	MIXTURE	183.0000	27.1887	4.8350	20.8887	(8)
CUL	8.	NET01	7012.0000	28.3188	4.8781	47.2387	(123)
SPAC	1.	204 PLANTS M	913.0000	38.8200	8.0784	28.7800	(28)
COMP	2.	MIXTURE	913.0000	38.8200	8.0784	28.7800	(28)
SPAC	3.	3 CM SPACING	1207.0000	37.7188	5.0178	25.1784	(32)
COMP	2.	MIXTURE	1207.0000	37.7188	5.0178	25.1784	(32)
SPAC	3.	8 CM SPACING	881.0000	40.0417	4.2781	18.3025	(24)
COMP	2.	MIXTURE	881.0000	40.0417	4.2781	18.3025	(24)
SPAC	4.	44 PLANTS M	1222.0000	38.4184	12.1378	147.3183	(31)
COMP	2.	MIXTURE	1222.0000	38.4184	12.1378	147.3183	(31)
SPAC	5.	28 PLANTS M	712.0000	38.8888	5.4788	30.0281	(18)
COMP	2.	MIXTURE	712.0000	38.8888	5.4788	30.0281	(18)
SPAC	6.	17 PLANTS M	800.0000	37.8000	8.8888	47.0438	(24)
COMP	2.	MIXTURE	800.0000	37.8000	8.8888	47.0438	(24)

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CRITERION VARIABLE PL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1097.0000	37.8278	4.2851	18.3821	(29)
COMP	2.	MIXTURE	1097.0000	37.8278	4.2851	18.3821	(29)
TOTAL CASES =	1080						
MISSING CASES =	32 OR	3.0 PCT.					

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FILE WP77 (CREATION DATE= 03/16/82)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE BROKEN DOWN BY	BY	BY	BY	BY	BY	BY	BY	BY
DESCRIPTION OF SUBPOPULATIONS	HEADS PER PLANT	CULTIVAR	INTER-PLANT	SPACING	TREATMENT			
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
FOR ENTIRE POPULATION			7821.0000	7.2898	5.0084	25.0845	(1044)	
CUL	2.	ELENLEA	1800.0000	8.8398	8.7422	45.4575	(181)	
SPAC	1.	204 PLANTS M	54.0000	3.8187	1.7917	3.2101	(24)	
COMP	1.	MONOCULTURE	44.0000	4.0000	1.7889	3.2000	(11)	
COMP	2.	MIXTURE	50.0000	3.8462	1.8840	3.4744	(13)	
SPAC	2.	3 CM SPACING	151.0000	4.4412	1.3989	1.9510	(34)	
COMP	1.	MONOCULTURE	58.0000	4.4816	1.3914	1.9389	(13)	
COMP	2.	MIXTURE	93.0000	4.4288	1.4343	2.0371	(21)	
SPAC	3.	9 CM SPACING	192.0000	5.4887	1.8210	3.3180	(35)	
COMP	1.	MONOCULTURE	69.0000	5.2308	1.8892	3.5588	(13)	
COMP	2.	MIXTURE	124.0000	5.8384	1.8951	3.5815	(22)	
SPAC	4.	44 PLANTS M	238.0000	8.2089	2.2580	5.0985	(29)	
COMP	1.	MONOCULTURE	111.0000	8.8398	1.7814	3.1028	(13)	
COMP	2.	MIXTURE	127.0000	7.9375	2.6198	6.8525	(18)	
SPAC	5.	28 PLANTS M	240.0000	12.0000	5.6008	31.3684	(20)	
COMP	1.	MONOCULTURE	159.0000	10.5333	4.3403	18.8381	(15)	
COMP	2.	MIXTURE	82.0000	18.4000	7.1274	50.8000	(5)	
SPAC	6.	17 PLANTS M	280.0000	14.5000	8.1000	37.2105	(20)	
COMP	1.	MONOCULTURE	202.0000	15.8385	5.0589	25.8028	(13)	
COMP	2.	MIXTURE	88.0000	12.5714	7.7428	89.9524	(7)	
SPAC	7.	10 PLANTS M	385.0000	20.7895	8.4863	71.5088	(18)	
COMP	1.	MONOCULTURE	181.0000	20.1250	5.1113	26.1250	(8)	

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CRITERION VARIABLE M

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	234.0000	21.2727	10.4794	109.8182	(11)
CUL	3.	PARK	1337.0000	8.4903	3.3888	11.4708	(208)
SPAC	1.	204 PLANTS M	102.0000	4.0800	1.7059	2.9100	(28)
COMP	1.	MONOCULTURE	34.0000	4.0000	1.8974	3.6000	(8)
COMP	2.	MIXTURE	78.0000	4.1053	1.8982	2.8772	(19)
SPAC	2.	3 CM SPACING	188.0000	4.8500	2.3853	5.6897	(40)
COMP	1.	MONOCULTURE	78.0000	8.0000	1.2347	1.5000	(13)
COMP	2.	MIXTURE	120.0000	4.8444	2.8508	7.0258	(27)
SPAC	3.	9 CM SPACING	178.0000	5.8938	2.1077	4.4425	(32)
COMP	1.	MONOCULTURE	74.0000	8.1887	1.8990	3.6081	(12)
COMP	2.	MIXTURE	108.0000	5.3500	2.1975	4.8289	(20)
SPAC	4.	44 PLANTS M	180.0000	8.7857	2.8854	7.2118	(28)
COMP	1.	MONOCULTURE	75.0000	8.8182	2.8803	8.2838	(11)
COMP	2.	MIXTURE	115.0000	8.7847	2.8867	8.8912	(17)
SPAC	5.	28 PLANTS M	244.0000	8.4138	2.1132	4.4855	(29)
COMP	1.	MONOCULTURE	121.0000	8.0887	2.4831	6.0887	(18)
COMP	2.	MIXTURE	123.0000	8.7887	1.8723	2.7887	(14)
SPAC	8.	17 PLANTS M	223.0000	8.8788	5.1709	28.7338	(28)
COMP	1.	MONOCULTURE	108.0000	8.3077	3.3283	11.0841	(13)
COMP	2.	MIXTURE	115.0000	8.8482	8.8588	44.4744	(13)
SPAC	7.	10 PLANTS M	201.0000	7.7309	4.0255	16.2048	(28)
COMP	1.	MONOCULTURE	83.0000	8.3848	4.1841	17.2884	(13)
COMP	2.	MIXTURE	118.0000	8.0788	3.8484	12.8788	(13)
CUL	4.	TOMODORO02	808.0000	8.9313	4.0004	16.0021	(131)
SPAC	1.	204 PLANTS M	88.0000	4.2800	2.1491	4.6184	(20)
COMP	1.	MIXTURE	88.0000	4.2800	2.1491	4.6184	(20)
SPAC	3.	3 CM SPACING	88.0000	4.2808	1.8838	3.4743	(23)
COMP	2.	MIXTURE	88.0000	8.2808	1.8838	3.4743	(23)

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CRITERION VARIABLE M

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	128.0000	8.4000	2.4388	5.9388	(20)
COMP	2.	MIXTURE	128.0000	8.4000	2.4388	5.9388	(20)
SPAC	4.	44 PLANTS M	101.0000	8.8412	1.8834	3.8338	(17)
COMP	2.	MIXTURE	101.0000	8.8412	1.8834	3.8338	(17)
SPAC	5.	28 PLANTS M	182.0000	8.5263	3.4700	12.0409	(19)
COMP	2.	MIXTURE	182.0000	8.5283	3.4700	12.0409	(19)
SPAC	8.	17 PLANTS M	188.0000	9.2500	3.8884	12.9342	(20)
COMP	2.	MIXTURE	188.0000	9.2500	3.8884	12.9342	(20)
SPAC	7.	10 PLANTS M	148.0000	12.4187	8.2888	39.1742	(12)
COMP	2.	MIXTURE	148.0000	12.4187	8.2888	39.1742	(12)
CUL	8.	NOROUAY	921.0000	8.3817	4.8743	20.8240	(145)
SPAC	1.	204 PLANTS M	124.0000	3.8288	2.0791	4.3227	(38)
COMP	1.	MONOCULTURE	82.0000	3.9375	1.1818	1.3958	(18)
COMP	2.	MIXTURE	71.0000	3.7388	2.8424	8.9825	(19)
SPAC	2.	3 CM SPACING	108.0000	8.0478	1.8021	3.2478	(21)
COMP	1.	MONOCULTURE	88.0000	8.8000	2.0111	4.0444	(10)
COMP	2.	MIXTURE	80.0000	4.8488	1.8078	2.2727	(11)
SPAC	3.	9 CM SPACING	104.0000	4.5217	1.8238	3.3518	(23)
COMP	1.	MONOCULTURE	43.0000	4.3000	1.8888	3.5567	(10)
COMP	2.	MIXTURE	81.0000	4.8823	1.2508	1.5641	(13)
SPAC	4.	44 PLANTS M	200.0000	7.4074	2.8590	8.1738	(27)
COMP	1.	MONOCULTURE	88.0000	8.0000	2.8888	8.0000	(11)
COMP	2.	MIXTURE	112.0000	7.0000	2.8048	7.8867	(18)
SPAC	8.	28 PLANTS M	80.0000	8.8887	3.8780	12.7879	(12)
COMP	1.	MONOCULTURE	80.0000	8.8887	3.8780	12.7879	(12)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	89.0000	8.8250	8.8870	43.1250	(8)
COMP	1.	MONOCULTURE	89.0000	8.8250	8.8870	43.1250	(8)
SPAC	7.	10 PLANTS M	228.0000	12.0000	7.7480	80.0000	(18)
COMP	1.	MONOCULTURE	102.0000	11.3333	8.0000	38.0000	(6)
COMP	2.	MIXTURE	126.0000	12.6000	8.3357	57.1889	(10)
CUL	8.	70M008002	888.0000	8.7834	4.9019	24.0282	(131)
SPAC	1.	204 PLANTS M	81.0000	3.3889	1.2897	1.8634	(18)
COMP	2.	MIXTURE	81.0000	3.3889	1.2897	1.8634	(18)
SPAC	2.	3 CM SPACING	83.0000	3.7727	1.4778	2.1840	(22)
COMP	2.	MIXTURE	83.0000	3.7727	1.4778	2.1840	(22)
SPAC	3.	8 CM SPACING	84.0000	4.8887	2.0884	4.3628	(18)
COMP	2.	MIXTURE	84.0000	4.8887	2.0884	4.3628	(18)
SPAC	4.	44 PLANTS M	80.0000	8.8887	2.3484	5.5182	(12)
COMP	2.	MIXTURE	80.0000	8.8887	2.3484	5.5182	(12)
SPAC	5.	28 PLANTS M	119.0000	8.8111	3.3279	11.0782	(18)
COMP	2.	MIXTURE	119.0000	8.8111	3.3279	11.0782	(18)
SPAC	6.	17 PLANTS M	208.0000	8.4648	4.5327	20.5488	(22)
COMP	2.	MIXTURE	208.0000	8.4648	4.5327	20.5488	(22)
SPAC	7.	10 PLANTS M	281.0000	11.8524	7.3788	84.4478	(21)
COMP	2.	MIXTURE	281.0000	11.8524	7.3788	84.4478	(21)
CUL	7.	NOROUAY	880.0000	8.8507	5.7842	33.4688	(89)
SPAC	1.	204 PLANTS M	40.0000	4.4444	0.8819	0.7778	(8)
COMP	2.	MIXTURE	40.0000	4.4444	0.8819	0.7778	(8)
SPAC	2.	3 CM SPACING	82.0000	8.1887	1.8824	3.8887	(12)
COMP	1.	MONOCULTURE	30.0000	8.0000	3.8288	8.4080	(6)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	32.0000	8.3333	1.8088	2.2667	(8)
SPAC	3.	8 CM SPACING	31.0000	8.1887	2.8394	8.0667	(8)
COMP	1.	MONOCULTURE	31.0000	8.1887	2.8394	8.0667	(8)
SPAC	4.	44 PLANTS M	84.0000	7.7143	2.8904	7.2381	(7)
COMP	1.	MONOCULTURE	84.0000	7.7143	2.8904	7.2381	(7)
SPAC	5.	28 PLANTS M	83.0000	11.8250	3.4200	11.8884	(8)
COMP	2.	MIXTURE	83.0000	11.8250	3.4200	11.8884	(8)
SPAC	6.	17 PLANTS M	174.0000	11.8000	7.0890	49.9714	(15)
COMP	2.	MIXTURE	174.0000	11.8000	7.0890	49.9714	(15)
SPAC	7.	10 PLANTS M	126.0000	11.3333	7.8468	83.1818	(12)
COMP	1.	MONOCULTURE	72.0000	12.0000	8.8128	92.4000	(6)
COMP	2.	MIXTURE	84.0000	10.8887	8.7429	45.4887	(6)
CUL	8.	N8701	1278.0000	7.8188	4.8892	23.8708	(181)
SPAC	1.	204 PLANTS M	104.0000	4.1800	1.2477	1.5547	(26)
COMP	2.	MIXTURE	104.0000	4.1800	1.2477	1.5547	(26)
SPAC	2.	3 CM SPACING	133.0000	4.2903	1.8772	2.8129	(31)
COMP	2.	MIXTURE	133.0000	4.2903	1.8772	2.8129	(31)
SPAC	3.	8 CM SPACING	131.0000	8.4683	2.0212	4.0881	(24)
COMP	2.	MIXTURE	131.0000	8.4683	2.0212	4.0881	(24)
SPAC	4.	44 PLANTS M	208.0000	8.7087	2.7712	7.6788	(31)
COMP	2.	MIXTURE	208.0000	8.7087	2.7712	7.6788	(31)
SPAC	5.	28 PLANTS M	189.0000	11.0556	2.8986	8.3967	(18)
COMP	2.	MIXTURE	189.0000	11.0556	2.8986	8.3967	(18)
SPAC	6.	17 PLANTS M	285.0000	11.0870	5.4344	29.5278	(23)
COMP	2.	MIXTURE	285.0000	11.0870	5.4344	29.5278	(23)

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CRITERION VARIABLE M

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	349.0000	12.0345	8.4934	42.0345	(39)
COMP	2.	MIXTURE	349.0000	12.0345	8.4934	42.0345	(29)
TOTAL CASES =	1080						
MISSING CASES =	39 OR	3.3 PCT.					

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FILE WP77

(CREATION DATE = 03/16/82)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		T	TILLERS PER PLANT				
BY		CUL	CULTIVAR				
BY		SPAC	INTER-PLANT SPACING				
BY		COMP	TREATMENT				

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			10255.0000	9.7760	6.2432	38.9774	(1049)
CUL	2.	GLENLEA	2072.0000	11.3848	8.2191	67.8529	(182)
SPAC	1.	204 PLANTS M	123.0000	8.1290	3.1112	9.8703	(24)
COMP	1.	MONOCULTURE	84.0000	4.8091	2.8794	8.2628	(11)
COMP	2.	MIXTURE	89.0000	5.3077	3.4906	11.5841	(13)
SPAC	3.	3 CM SPACING	189.0000	5.3143	2.0259	4.1042	(35)
COMP	1.	MONOCULTURE	87.0000	4.7857	1.8472	3.4121	(14)
COMP	2.	MIXTURE	119.0000	5.8867	2.1085	4.4333	(21)
SPAC	3.	6 CM SPACING	248.0000	7.1143	2.8983	7.2807	(35)
COMP	1.	MONOCULTURE	80.0000	5.1538	1.8788	3.5277	(13)
COMP	2.	MIXTURE	189.0000	7.6818	3.0455	9.2749	(22)
SPAC	4.	44 PLANTS M	320.0000	11.0345	3.3433	11.1773	(29)
COMP	1.	MONOCULTURE	135.0000	10.3848	1.9807	3.9231	(13)
COMP	2.	MIXTURE	185.0000	11.8825	4.1307	17.0625	(16)
SPAC	5.	28 PLANTS M	299.0000	14.9500	6.2448	38.8974	(20)
COMP	1.	MONOCULTURE	191.0000	12.7333	4.8788	23.7810	(15)
COMP	2.	MIXTURE	108.0000	21.6000	5.3198	28.3000	(8)
SPAC	6.	17 PLANTS M	379.0000	18.9500	8.0833	25.8395	(20)
COMP	1.	MONOCULTURE	247.0000	18.0000	4.3589	19.0000	(13)
COMP	2.	MIXTURE	132.0000	18.8571	6.8189	43.8095	(7)
SPAC	7.	10 PLANTS M	616.0000	27.1879	7.7263	59.8859	(19)
COMP	1.	MONOCULTURE	195.0000	24.3750	6.3457	40.2679	(8)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	321.0000	28.1818	8.2803	68.5838	(11)
CUL	3.	PARK	1848.0000	8.9130	4.5788	20.8633	(207)
SPAC	1.	204 PLANTS M	134.0000	8.3800	2.2338	4.8900	(25)
COMP	1.	MONOCULTURE	33.0000	8.8000	1.8708	3.5000	(8)
COMP	2.	MIXTURE	101.0000	8.3188	2.3817	5.6728	(19)
SPAC	2.	3 CM SPACING	289.0000	8.8810	3.1547	9.9524	(41)
COMP	1.	MONOCULTURE	114.0000	8.1428	3.0081	9.0548	(14)
COMP	2.	MIXTURE	185.0000	8.7407	2.9880	8.7379	(27)
SPAC	3.	9 CM SPACING	281.0000	7.8438	3.0278	9.1683	(32)
COMP	1.	MONOCULTURE	101.0000	8.4187	3.0888	9.5561	(12)
COMP	2.	MIXTURE	180.0000	7.8000	3.0348	9.2108	(20)
SPAC	4.	44 PLANTS M	248.0000	8.7800	3.8848	14.9382	(28)
COMP	1.	MONOCULTURE	89.0000	8.0000	4.3288	18.8000	(11)
COMP	2.	MIXTURE	148.0000	8.8882	3.8882	13.3824	(17)
SPAC	5.	28 PLANTS M	304.0000	10.4828	2.6271	6.8018	(39)
COMP	1.	MONOCULTURE	188.0000	10.3333	3.1081	9.6887	(18)
COMP	2.	MIXTURE	148.0000	10.8428	2.0878	4.4011	(14)
SPAC	6.	17 PLANTS M	317.0000	12.1823	8.8001	31.3818	(28)
COMP	1.	MONOCULTURE	188.0000	12.8823	8.4218	28.3874	(13)
COMP	2.	MIXTURE	182.0000	11.8823	8.8488	28.3874	(13)
SPAC	7.	10 PLANTS M	328.0000	12.8000	8.8008	34.8200	(28)
COMP	1.	MONOCULTURE	184.0000	11.8482	8.1488	37.8077	(13)
COMP	2.	MIXTURE	171.0000	13.1838	8.8144	33.8077	(13)
CUL	4.	700000002	1289.0000	9.8107	8.0833	26.8398	(131)
SPAC	1.	204 PLANTS M	118.0000	8.7800	3.4008	11.8888	(20)
COMP	2.	MIXTURE	118.0000	8.7800	3.4008	11.8888	(20)
SPAC	2.	3 CM SPACING	142.0000	8.1738	2.8798	8.8778	(23)
COMP	2.	MIXTURE	142.0000	8.1738	2.8798	8.8778	(23)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	189.0000	9.4500	3.8317	14.6818	(20)
COMP	2.	MIXTURE	189.0000	9.4500	3.8317	14.6818	(20)
SPAC	4.	44 PLANTS M	148.0000	8.8882	2.8888	8.7874	(17)
COMP	2.	MIXTURE	148.0000	8.8882	2.8888	8.7874	(17)
SPAC	5.	28 PLANTS M	228.0000	12.0528	3.7838	14.1837	(19)
COMP	2.	MIXTURE	228.0000	12.0528	3.7838	14.1837	(19)
SPAC	6.	17 PLANTS M	288.0000	12.8000	4.0079	16.0832	(20)
COMP	2.	MIXTURE	288.0000	12.8000	4.0079	16.0832	(20)
SPAC	7.	10 PLANTS M	182.0000	15.1887	8.0888	88.6081	(12)
COMP	2.	MIXTURE	182.0000	15.1887	8.0888	88.6081	(12)
CUL	5.	NORQUAY	1181.0000	8.0889	8.8782	38.7808	(148)
SPAC	1.	204 PLANTS M	182.0000	4.3428	2.3288	5.4084	(38)
COMP	1.	MONOCULTURE	88.0000	4.2500	1.1822	1.4000	(18)
COMP	2.	MIXTURE	84.0000	4.4211	3.0088	9.0381	(19)
SPAC	2.	3 CM SPACING	128.0000	5.8838	3.1887	10.0281	(22)
COMP	1.	MONOCULTURE	72.0000	7.3000	3.8488	18.8887	(10)
COMP	2.	MIXTURE	88.0000	4.8887	1.7233	2.9887	(12)
SPAC	3.	9 CM SPACING	144.0000	8.2808	2.8288	8.3834	(23)
COMP	1.	MONOCULTURE	83.0000	8.3000	2.3884	5.6887	(10)
COMP	2.	MIXTURE	91.0000	7.0000	2.4833	6.1887	(13)
SPAC	4.	44 PLANTS M	282.0000	9.3704	3.8248	14.6288	(27)
COMP	1.	MONOCULTURE	107.0000	8.7273	4.1738	17.4182	(11)
COMP	2.	MIXTURE	148.0000	9.1280	3.8888	13.8833	(18)
SPAC	5.	28 PLANTS M	108.0000	8.7800	4.8382	20.8882	(12)
COMP	1.	MONOCULTURE	108.0000	8.7800	4.8382	20.8882	(12)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	88.0000	10.7800	7.3241	53.6429	(8)
COMP	1.	MONOCULTURE	88.0000	10.7800	7.3241	53.6429	(8)
SPAC	7.	10 PLANTS M	312.0000	18.4211	9.3233	88.8240	(10)
COMP	1.	MONOCULTURE	132.0000	14.8667	8.7034	75.7800	(8)
COMP	2.	MIXTURE	180.0000	18.0000	10.0333	100.6667	(10)
CUL	8.	TOMODS002	1248.0000	8.5115	8.1138	37.3749	(131)
SPAC	1.	204 PLANTS M	78.0000	4.2222	3.1030	4.4183	(18)
COMP	2.	MIXTURE	78.0000	4.2222	3.1030	4.4183	(18)
SPAC	2.	3 CM SPACING	105.0000	4.7727	1.7877	3.2318	(22)
COMP	2.	MIXTURE	105.0000	4.7727	1.7877	3.2318	(22)
SPAC	3.	9 CM SPACING	113.0000	8.2778	2.9487	8.6830	(18)
COMP	2.	MIXTURE	113.0000	8.2778	2.9487	8.6830	(18)
SPAC	4.	44 PLANTS M	123.0000	10.2800	3.4145	11.6891	(12)
COMP	2.	MIXTURE	123.0000	10.2800	3.4145	11.6891	(12)
SPAC	5.	28 PLANTS M	178.0000	9.7778	4.2778	18.3007	(18)
COMP	2.	MIXTURE	178.0000	9.7778	4.2778	18.3007	(18)
SPAC	8.	17 PLANTS M	309.0000	14.0488	8.2088	38.8218	(22)
COMP	2.	MIXTURE	309.0000	14.0488	8.2088	38.8218	(22)
SPAC	7.	10 PLANTS M	344.0000	18.3810	8.8438	34.1478	(21)
COMP	2.	MIXTURE	344.0000	18.3810	8.8438	34.1478	(21)
CUL	7.	HDRQUAY	840.0000	12.1739	7.1413	50.9887	(89)
SPAC	1.	204 PLANTS M	40.0000	4.4444	0.8819	0.7778	(9)
COMP	2.	MIXTURE	40.0000	4.4444	0.8819	0.7778	(9)
SPAC	2.	3 CM SPACING	80.0000	8.8887	3.2848	10.7878	(12)
COMP	1.	MONOCULTURE	48.0000	7.8887	4.3888	18.0887	(8)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	34.0000	8.6887	1.5085	2.2887	(8)
SPAC	3.	8 CM SPACING	47.0000	7.8333	3.8707	15.7887	(8)
COMP	1.	MONOCULTURE	47.0000	7.8333	3.8707	15.7887	(8)
SPAC	4.	44 PLANTS M	90.0000	12.8571	2.8538	8.1429	(7)
COMP	1.	MONOCULTURE	80.0000	12.8571	2.8538	8.1429	(7)
SPAC	5.	28 PLANTS M	132.0000	18.6000	3.6848	13.4288	(8)
COMP	2.	MIXTURE	132.0000	18.6000	3.6848	13.4288	(8)
SPAC	8.	17 PLANTS M	223.0000	14.8667	5.8665	35.8381	(15)
COMP	2.	MIXTURE	223.0000	14.8667	5.8665	35.8381	(15)
SPAC	7.	10 PLANTS M	232.0000	18.0000	8.4523	71.2727	(12)
COMP	1.	MONOCULTURE	112.0000	18.6667	8.8284	78.8667	(8)
COMP	2.	MIXTURE	118.0000	18.3333	8.7880	76.8887	(8)
CUL	8.	WBT01	1812.0000	9.9018	5.7222	32.8584	(183)
SPAC	1.	204 PLANTS M	140.0000	5.6000	1.8028	3.2800	(28)
COMP	2.	MIXTURE	140.0000	5.6000	1.8028	3.2800	(28)
SPAC	2.	3 CM SPACING	174.0000	8.4375	2.2892	8.2883	(32)
COMP	2.	MIXTURE	174.0000	8.4375	2.2892	8.2883	(32)
SPAC	3.	8 CM SPACING	188.0000	8.9187	3.9180	8.5148	(24)
COMP	2.	MIXTURE	188.0000	8.9187	3.9180	8.5148	(24)
SPAC	4.	44 PLANTS M	274.0000	8.8387	3.8815	13.4088	(31)
COMP	2.	MIXTURE	274.0000	8.8387	3.8815	13.4088	(31)
SPAC	5.	28 PLANTS M	228.0000	12.7222	3.3220	11.0389	(18)
COMP	2.	MIXTURE	228.0000	12.7222	3.3220	11.0389	(18)
SPAC	8.	17 PLANTS M	384.0000	15.1887	8.0982	37.1884	(24)
COMP	2.	MIXTURE	384.0000	15.1887	8.0982	37.1884	(24)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	488.0000	18.0348	8.8084	30.3202	(28)
COMP	2.	MIXTURE	488.0000	18.0348	8.8084	30.3202	(28)
TOTAL CASES = 1080							
MISSING CASES = 31 OR 2.8 PCT.							

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FILE WP77 (CREATION DATE = 03/16/82)

CRITERION VARIABLE T

CRITERION VARIABLE		WT	SUBPOPULATIONS		DRY WEIGHT PER PLANT G			
BROKEN DOWN BY		CUL			CULTIVAR			
		BY			INTER-PLANT SPACING			
		BY			TREATMENT			

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
FOR ENTIRE POPULATION			48123.3226	46.0810	28.8886	823.4380	(1045)	

CUL	3.	GLENLEA	10824.2487	58.1450	35.9138	1289.7875	(181)	
SPAC	1.	204 PLANTS M	744.4889	31.0204	14.8601	223.8083	(24)	
COMP	1.	MONOCULTURE	387.2889	33.3882	18.8910	278.2818	(11)	
COMP	2.	MIXTURE	377.2199	29.0189	13.7684	189.5149	(13)	

SPAC	3.	3 CM SPACING	1130.3888	32.2889	7.8575	61.7404	(35)	
COMP	1.	MONOCULTURE	438.8489	31.3484	8.0405	64.8502	(14)	
COMP	2.	MIXTURE	691.5399	32.8308	7.8685	61.8822	(21)	

SPAC	3.	8 CM SPACING	1328.4087	38.1831	10.2481	104.8828	(35)	
COMP	1.	MONOCULTURE	489.9889	38.1831	8.8787	78.3197	(13)	
COMP	2.	MIXTURE	838.4198	38.3827	11.0834	122.8410	(22)	

SPAC	4.	44 PLANTS M	1528.3888	54.8211	12.2480	149.9387	(28)	
COMP	1.	MONOCULTURE	700.6189	53.8861	8.8672	87.1882	(12)	
COMP	2.	MIXTURE	828.7699	58.2880	18.7420	247.8120	(16)	

SPAC	5.	28 PLANTS M	1443.9388	72.1970	22.4485	503.9388	(20)	
COMP	1.	MONOCULTURE	887.7289	68.8487	18.4882	380.1800	(18)	
COMP	2.	MIXTURE	488.2100	61.2420	21.4138	458.8490	(8)	

SPAC	6.	17 PLANTS M	1870.4889	88.8238	31.4351	988.1851	(20)	
COMP	1.	MONOCULTURE	1288.8289	88.2023	33.8852	854.8488	(12)	
COMP	2.	MIXTURE	880.8400	87.2828	44.8071	2018.8433	(7)	

SPAC	7.	10 PLANTS M	2388.1889	124.6928	28.7888	717.8381	(18)	
COMP	1.	MONOCULTURE	988.1089	118.3887	18.8841	388.8837	(8)	

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CRITERION VARIABLE WT								
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
	2.	MIXTURE	1414.0500	126.5500	31.2071	973.8818	(	11)
CUL	3.	PARK	7882.2288	38.7088	13.3810	178.8180	(	208)
SPAC	1.	204 PLANTS M	827.3488	38.0940	8.4300	28.4851	(	28)
COMP	1.	MONOCULTURE	145.8400	24.3087	8.0088	28.0978	(	8)
COMP	2.	MIXTURE	481.8088	28.3428	8.8830	32.6700	(	19)
SPAC	2.	3 CM SPACING	1131.8088	27.8002	7.3853	84.8808	(	41)
COMP	1.	MONOCULTURE	422.1188	30.1814	8.8427	42.8073	(	14)
COMP	2.	MIXTURE	708.4888	28.2774	7.8772	87.4138	(	27)
SPAC	3.	8 CM SPACING	1033.0788	32.2837	8.3310	40.0813	(	32)
COMP	1.	MONOCULTURE	408.8088	34.1808	8.1031	37.2474	(	12)
COMP	2.	MIXTURE	823.2888	31.1838	8.3488	40.3088	(	20)
SPAC	4.	44 PLANTS M	1003.2288	37.1887	8.8810	80.8888	(	27)
COMP	1.	MONOCULTURE	412.4088	37.4818	8.7408	84.8838	(	11)
COMP	2.	MIXTURE	590.8188	36.8282	8.7418	78.4138	(	18)
SPAC	5.	28 PLANTS M	1354.3288	48.7010	9.1787	84.2480	(	28)
COMP	1.	MONOCULTURE	881.8388	48.1227	10.8438	118.7874	(	18)
COMP	2.	MIXTURE	882.4888	47.3207	7.1887	81.8773	(	14)
SPAC	6.	17 PLANTS M	1224.0388	47.0788	17.3340	300.4888	(	28)
COMP	1.	MONOCULTURE	832.8888	48.8823	18.8788	242.8282	(	13)
COMP	2.	MIXTURE	881.1888	48.4748	18.4384	377.7742	(	13)
SPAC	7.	10 PLANTS M	1188.8888	48.7180	14.8381	211.3888	(	28)
COMP	1.	MONOCULTURE	880.7288	43.1331	18.8888	278.4217	(	13)
COMP	2.	MIXTURE	827.8888	48.2888	12.2882	180.4888	(	13)
CUL	4.	70008002	4883.7381	38.7837	18.8020	248.7017	(	131)
SPAC	1.	204 PLANTS M	448.8088	22.4808	8.2118	27.1827	(	20)
COMP	2.	MIXTURE	448.8088	22.4808	8.2118	27.1827	(	20)
SPAC	2.	3 CM SPACING	877.3488	28.1022	8.4300	41.3443	(	23)
COMP	2.	MIXTURE	877.3488	28.1022	8.4300	41.3443	(	23)

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CRITERION VARIABLE WT								
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
SPAC	3.	8 CM SPACING	840.2888	32.0150	8.7804	98.2884	(	20)
COMP	2.	MIXTURE	840.2888	32.0150	8.7804	98.2884	(	20)
SPAC	4.	44 PLANTS M	884.8288	32.8371	8.0814	84.8281	(	17)
COMP	2.	MIXTURE	884.8288	32.8371	8.0814	84.8281	(	17)
SPAC	5.	28 PLANTS M	888.3388	48.0178	11.7802	138.3033	(	18)
COMP	2.	MIXTURE	888.3388	48.0178	11.7802	138.3033	(	18)
SPAC	6.	17 PLANTS M	838.3888	48.8700	14.8408	220.2480	(	20)
COMP	2.	MIXTURE	838.3888	48.8700	14.8408	220.2480	(	20)
SPAC	7.	10 PLANTS M	888.8088	58.8788	23.4887	582.2382	(	12)
COMP	2.	MIXTURE	888.8088	58.8788	23.4887	582.2382	(	12)
CUL	5.	WROUAY	8870.4880	38.1838	23.8808	888.0484	(	148)
SPAC	1.	204 PLANTS M	847.8888	24.2180	7.1483	81.0884	(	35)
COMP	1.	MONOCULTURE	382.1288	23.8831	4.7380	22.4488	(	18)
COMP	2.	MIXTURE	465.4288	24.4883	8.8108	77.8302	(	18)
SPAC	2.	3 CM SPACING	834.2488	28.8288	8.1088	82.8334	(	22)
COMP	1.	MONOCULTURE	332.2188	33.2220	10.8847	117.8240	(	10)
COMP	2.	MIXTURE	302.0300	28.1882	8.4882	28.7700	(	12)
SPAC	3.	8 CM SPACING	884.4888	28.4888	7.4171	88.0131	(	23)
COMP	1.	MONOCULTURE	288.7288	28.8730	8.1000	88.8082	(	10)
COMP	2.	MIXTURE	395.7888	30.4438	8.4880	41.8088	(	13)
SPAC	4.	44 PLANTS M	1083.0888	40.4848	10.8844	118.9878	(	27)
COMP	1.	MONOCULTURE	478.1888	43.2808	12.0082	144.1888	(	11)
COMP	2.	MIXTURE	818.8888	38.8888	10.1088	102.1210	(	18)
SPAC	5.	28 PLANTS M	487.3488	38.8488	16.2888	288.3488	(	12)
COMP	1.	MONOCULTURE	487.3488	38.8488	16.2888	288.3488	(	12)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	481.8400	57.7050	28.8408	878.5783	(8)
COMP	1.	MONOCULTURE	481.8400	57.7050	28.8408	878.5783	(8)
SPAC	7.	10 PLANTS M	1412.0788	74.3300	37.1257	1378.3188	(18)
COMP	1.	MONOCULTURE	888.1888	88.2411	28.0838	789.2514	(8)
COMP	2.	MIXTURE	515.9098	51.5910	43.8438	1831.0848	(10)
CUL	8.	70000000	5782.2880	51.8408	42.0288	1788.4887	(130)
SPAC	1.	204 PLANTS M	820.1188	34.4811	41.7818	1744.0480	(18)
COMP	2.	MIXTURE	820.1188	34.4811	41.7818	1744.0480	(18)
SPAC	2.	3 CM SPACING	1080.0087	80.0008	78.8840	8712.8373	(21)
COMP	2.	MIXTURE	1080.0087	80.0008	78.8840	8712.8373	(21)
SPAC	3.	9 CM SPACING	880.8888	30.8822	8.1202	37.4888	(18)
COMP	2.	MIXTURE	880.8888	30.8822	8.1202	37.4888	(18)
SPAC	4.	44 PLANTS M	578.0288	47.9182	20.1818	407.8871	(12)
COMP	2.	MIXTURE	578.0288	47.9182	20.1818	407.8871	(12)
SPAC	5.	28 PLANTS M	788.3188	44.4087	13.4081	178.7788	(18)
COMP	2.	MIXTURE	788.3188	44.4087	13.4081	178.7788	(18)
SPAC	6.	17 PLANTS M	1482.8288	88.4788	33.8083	1143.0028	(22)
COMP	2.	MIXTURE	1482.8288	88.4788	33.8083	1143.0028	(22)
SPAC	7.	10 PLANTS M	1884.8888	80.8882	27.1788	738.8870	(21)
COMP	2.	MIXTURE	1884.8888	80.8882	27.1788	738.8870	(21)
CUL	7.	NORQUAY	3488.8288	50.5284	28.8874	727.2431	(88)
SPAC	1.	204 PLANTS M	231.1888	28.8888	4.8848	20.7431	(8)
COMP	2.	MIXTURE	231.1888	28.8888	4.8848	20.7431	(8)
SPAC	2.	3 CM SPACING	341.2088	28.4342	8.8138	74.1881	(12)
COMP	1.	MONOCULTURE	172.8800	28.7787	11.8218	138.7478	(8)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	188.5488	28.0917	4.8178	23.2080	(6)
SPAC	3.	9 CM SPACING	182.4800	30.4180	12.8848	181.1841	(6)
COMP	1.	MONOCULTURE	182.4800	30.4180	12.8848	181.1841	(6)
SPAC	4.	44 PLANTS M	313.7800	44.8257	8.8777	80.8894	(7)
COMP	1.	MONOCULTURE	313.7800	44.8257	8.8777	80.8894	(7)
SPAC	5.	28 PLANTS M	884.8800	70.8812	8.7318	48.3178	(8)
COMP	2.	MIXTURE	884.8800	70.8812	8.7318	48.3178	(8)
SPAC	6.	17 PLANTS M	948.8088	63.0607	21.7388	472.8801	(15)
COMP	2.	MIXTURE	948.8088	63.0607	21.7388	472.8801	(15)
SPAC	7.	10 PLANTS M	807.8888	78.8417	34.4317	1185.8417	(12)
COMP	1.	MONOCULTURE	482.8400	77.1087	38.8888	1888.8057	(8)
COMP	2.	MIXTURE	448.0600	74.1767	31.8348	1013.4380	(6)
CUL	8.	N8701	8543.4288	52.4384	28.7188	861.4824	(182)
SPAC	1.	204 PLANTS M	788.7788	31.4712	4.3832	18.8801	(28)
COMP	2.	MIXTURE	788.7788	31.4712	4.3832	18.8801	(28)
SPAC	2.	3 CM SPACING	880.4888	30.8838	8.7348	48.3848	(31)
COMP	2.	MIXTURE	880.4888	30.8838	8.7348	48.3848	(31)
SPAC	3.	9 CM SPACING	818.8188	38.3300	9.5233	90.8830	(24)
COMP	2.	MIXTURE	818.8188	38.3300	9.5233	90.8830	(24)
SPAC	4.	44 PLANTS M	1438.9387	48.4487	11.2088	128.8831	(31)
COMP	2.	MIXTURE	1438.9387	48.4487	11.2088	128.8831	(31)
SPAC	5.	28 PLANTS M	1220.8888	87.8088	12.3888	183.4348	(18)
COMP	2.	MIXTURE	1220.8888	87.8088	12.3888	183.4348	(18)
SPAC	6.	17 PLANTS M	1844.8888	78.8828	28.0851	788.7731	(24)
COMP	2.	MIXTURE	1844.8888	78.8828	28.0851	788.7731	(24)

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CRITERION VARIABLE	WT	VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC			7.	10 PLANTS M	2371.0398	81.7800	24.3921	894.9743	(29)
COMP			2.	MIXTURE	2371.0398	81.7800	24.3921	894.9743	(29)
TOTAL CASES =	1080								
MISSING CASES =	35 OR	3.2 PCT.							

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FILE WP77 (CREATION DATE = 03/18/82)

----- DESCRIPTION OF SUBPOPULATIONS -----

CRITERION VARIABLE	Y	DESCRIPTION	SEED YIELD PER PLANT
BROKEN DOWN BY	CUL	CULTIVAR	
BY	SPAC	INTER-PLANT SPACING	
BY	COMP	TREATMENT	

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14804.4174	14.2038	12.8480	165.0599	(1035)
CUL	2.	GUENEA	3829.4484	20.1538	18.2231	332.0818	(180)
SPAC	1.	204 PLANTS M	177.2400	7.7081	5.8273	33.9578	(23)
COMP	1.	MONOCULTURE	84.8500	7.7135	7.2159	52.0895	(11)
COMP	2.	MIXTURE	92.3900	7.6992	4.6365	20.8798	(12)
SPAC	2.	3 CM SPACING	271.7100	7.9818	3.1188	9.7285	(34)
COMP	1.	MONOCULTURE	84.4900	7.2885	3.2433	10.5188	(13)
COMP	2.	MIXTURE	177.2200	8.4390	3.0311	9.1875	(21)
SPAC	3.	8 CM SPACING	281.2100	10.3203	4.1891	17.3817	(35)
COMP	1.	MONOCULTURE	112.5500	8.6555	3.8728	14.9968	(13)
COMP	2.	MIXTURE	248.6600	11.3023	4.1052	16.8523	(22)
SPAC	4.	44 PLANTS M	486.0099	17.1038	5.3800	28.7300	(28)
COMP	1.	MONOCULTURE	217.0400	18.8984	3.2172	10.3503	(13)
COMP	2.	MIXTURE	278.9699	17.4358	6.7147	45.0870	(15)
SPAC	5.	28 PLANTS M	810.1388	25.8070	9.8384	82.8402	(20)
COMP	1.	MONOCULTURE	335.2999	22.3533	8.3744	70.1305	(15)
COMP	2.	MIXTURE	174.8400	34.8880	9.8051	48.3501	(8)
SPAC	6.	17 PLANTS M	751.3498	37.5575	15.4142	237.5888	(20)
COMP	1.	MONOCULTURE	473.8899	35.4300	12.3267	151.9579	(13)
COMP	2.	MIXTURE	277.4600	39.8800	20.8855	440.3899	(7)
SPAC	7.	10 PLANTS M	1081.7898	85.8837	20.4837	419.9902	(19)
COMP	1.	MONOCULTURE	353.3099	44.1837	15.3778	235.4594	(8)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	708.4788	84.4073	20.0183	400.8518	(11)
CUL	3.	PARK	1974.4487	8.5384	8.8880	32.3307	(207)
SPAC	1.	204 PLANTS M	114.7000	4.5880	2.4783	8.1487	(26)
COMP	1.	MONOCULTURE	24.7400	4.1233	2.2404	8.0193	(8)
COMP	2.	MIXTURE	89.8800	4.7347	2.6887	8.7088	(18)
SPAC	2.	3 CM SPACING	219.2800	8.3488	3.1348	8.8251	(41)
COMP	1.	MONOCULTURE	81.2700	8.8193	2.7448	7.8323	(14)
COMP	2.	MIXTURE	128.0200	4.7418	3.1882	10.2288	(27)
SPAC	3.	9 CM SPACING	241.1400	7.5388	2.8738	8.8440	(32)
COMP	1.	MONOCULTURE	100.0100	8.3343	2.8921	8.7188	(12)
COMP	2.	MIXTURE	141.1300	7.0888	3.1487	8.8988	(20)
SPAC	4.	44 PLANTS M	288.3400	10.2878	4.0280	18.2288	(28)
COMP	1.	MONOCULTURE	108.3800	9.8882	3.8844	14.8880	(11)
COMP	2.	MIXTURE	181.8900	10.7083	4.2008	17.8481	(17)
SPAC	8.	28 PLANTS M	407.3088	14.0482	4.7748	22.7883	(28)
COMP	1.	MONOCULTURE	188.8200	13.0847	8.4038	28.2008	(18)
COMP	2.	MIXTURE	211.4800	18.1084	3.8134	18.3148	(14)
SPAC	8.	17 PLANTS M	381.8388	13.8084	8.1801	37.8484	(28)
COMP	1.	MONOCULTURE	200.2800	18.4082	8.7372	48.2884	(13)
COMP	2.	MIXTURE	181.2800	12.4048	8.3777	28.8188	(13)
SPAC	7.	10 PLANTS M	342.1288	13.1888	8.0888	38.7102	(28)
COMP	1.	MONOCULTURE	187.2300	12.0848	7.0121	48.1883	(13)
COMP	2.	MIXTURE	184.8000	14.2231	4.8888	24.8883	(13)
CUL	4.	70000002	1315.8488	10.2004	7.2788	82.8784	(128)
SPAC	1.	204 PLANTS M	84.8700	4.2288	1.8882	3.8384	(20)
COMP	2.	MIXTURE	84.8700	4.2288	1.8882	3.8384	(20)
SPAC	2.	3 CM SPACING	118.8800	8.4348	2.3782	8.8887	(22)
COMP	2.	MIXTURE	118.8800	8.4348	2.3782	8.8887	(22)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	184.2000	8.2100	4.1278	17.0370	(20)
COMP	2.	MIXTURE	184.2000	8.2100	4.1278	17.0370	(20)
SPAC	4.	44 PLANTS M	151.7400	8.9288	3.3288	11.0804	(17)
COMP	2.	MIXTURE	151.7400	8.9288	3.3288	11.0804	(17)
SPAC	5.	28 PLANTS M	283.4400	13.8883	4.8844	20.8337	(19)
COMP	2.	MIXTURE	283.4400	13.8883	4.8844	20.8337	(19)
SPAC	6.	17 PLANTS M	318.8888	18.8888	7.3138	53.4877	(20)
COMP	2.	MIXTURE	318.8888	18.8888	7.3138	53.4877	(20)
SPAC	7.	10 PLANTS M	212.3700	19.3084	12.3888	153.7548	(11)
COMP	2.	MIXTURE	212.3700	19.3084	12.3888	153.7548	(11)
CUL	5.	NOROUAY	1748.2887	12.0388	11.8010	134.8840	(148)
SPAC	1.	204 PLANTS M	188.3400	8.3240	3.3414	11.1880	(38)
COMP	1.	MONOCULTURE	82.3700	8.7731	2.2704	8.1848	(18)
COMP	2.	MIXTURE	83.8700	4.8488	4.0578	18.4837	(18)
SPAC	2.	3 CM SPACING	147.0100	7.0008	3.8880	18.8878	(21)
COMP	1.	MONOCULTURE	81.8800	8.1088	4.8888	21.7888	(8)
COMP	2.	MIXTURE	88.0300	8.4182	2.6108	8.8188	(12)
SPAC	3.	9 CM SPACING	188.3800	7.1804	2.8083	7.8784	(23)
COMP	1.	MONOCULTURE	70.8400	7.0840	3.1883	10.2288	(10)
COMP	2.	MIXTURE	84.8400	7.2884	2.8880	8.7382	(13)
SPAC	4.	44 PLANTS M	348.5188	12.8482	8.8204	31.8880	(27)
COMP	1.	MONOCULTURE	188.1888	18.0148	8.1811	37.8388	(11)
COMP	2.	MIXTURE	184.3800	11.8228	4.8228	24.2313	(18)
SPAC	8.	28 PLANTS M	184.8100	13.7082	7.4881	88.0718	(12)
COMP	1.	MONOCULTURE	184.8100	13.7082	7.4881	88.0718	(12)

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CRITERION VARIABLE Y							
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	163.8000	20.4750	15.8208	278.2495	(8)
COMP	1.	MONOCULTURE	163.8000	20.4750	15.8208	278.2495	(8)
SPAC	7.	10 PLANTS M	558.7399	29.8327	17.8118	320.8281	(19)
COMP	1.	MONOCULTURE	232.2700	28.8188	13.3381	177.8308	(8)
COMP	2.	MIXTURE	336.4699	33.8470	21.2808	452.8590	(10)
CUL	8.	TOMOGS002	1982.0899	15.4928	14.8345	233.0407	(128)
SPAC	1.	204 PLANTS M	88.8500	4.8250	2.0789	4.3281	(18)
COMP	2.	MIXTURE	88.8500	4.8250	2.0789	4.3281	(18)
SPAC	2.	3 CM SPACING	121.0800	5.8023	2.4944	6.2221	(22)
COMP	2.	MIXTURE	121.0800	5.8023	2.4944	6.2221	(22)
SPAC	3.	9 CM SPACING	111.1200	5.9450	3.1230	9.7830	(18)
COMP	2.	MIXTURE	111.1200	5.9450	3.1230	9.7830	(18)
SPAC	4.	44 PLANTS M	179.3000	14.8417	8.8519	80.1388	(12)
COMP	2.	MIXTURE	179.3000	14.8417	8.8519	80.1388	(12)
SPAC	5.	28 PLANTS M	254.4299	14.1380	7.1222	50.7284	(18)
COMP	2.	MIXTURE	254.4299	14.1380	7.1222	50.7284	(18)
SPAC	6.	17 PLANTS M	555.8799	25.2718	18.4032	338.8788	(22)
COMP	2.	MIXTURE	555.8799	25.2718	18.4032	338.8788	(22)
SPAC	7.	10 PLANTS M	572.5599	33.8280	18.2845	284.8344	(20)
COMP	2.	MIXTURE	572.5599	33.8280	18.2845	284.8344	(20)
CUL	7.	NORQUAY	1088.7599	18.9040	12.3823	153.3473	(68)
SPAC	1.	204 PLANTS M	41.8400	5.2428	1.8082	3.8414	(8)
COMP	2.	MIXTURE	41.8400	5.2428	1.8082	3.8414	(8)
SPAC	2.	3 CM SPACING	86.8300	7.8884	4.3158	18.8282	(11)
COMP	1.	MONOCULTURE	83.7000	8.9800	5.4340	28.8280	(8)

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CRITERION VARIABLE Y								
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
COMP	2.	MIXTURE	32.8300	5.5580	2.4042	5.7803	(	5)
SPAC	3.	9 CM SPACING	82.7000	10.4500	5.2289	28.8114	(	8)
COMP	1.	MONOCULTURE	82.7000	10.4500	5.2289	28.8114	(	8)
SPAC	4.	44 PLANTS M	82.8100	13.8017	5.8807	32.2708	(	6)
COMP	1.	MONOCULTURE	82.8100	13.8017	5.8807	32.2708	(	6)
SPAC	5.	28 PLANTS M	178.5999	25.0857	4.8738	24.7380	(	7)
COMP	2.	MIXTURE	178.5999	25.0857	4.8738	24.7380	(	7)
SPAC	6.	17 PLANTS M	307.6189	20.8080	8.3253	68.8805	(	15)
COMP	2.	MIXTURE	307.6189	20.8080	8.3253	68.8805	(	15)
SPAC	7.	10 PLANTS M	341.5599	28.4633	17.3737	301.8448	(	12)
COMP	1.	MONOCULTURE	198.7900	33.1317	20.3637	414.8803	(	6)
COMP	2.	MIXTURE	142.7700	23.7950	14.0383	197.0743	(	6)
CUL	8.	NE701	3057.5184	18.8824	11.7013	136.9213	(	181)
SPAC	1.	204 PLANTS M	187.8700	7.5148	2.2240	4.9462	(	25)
COMP	2.	MIXTURE	187.8700	7.5148	2.2240	4.9462	(	25)
SPAC	2.	3 CM SPACING	232.8800	7.2718	3.1041	9.8357	(	32)
COMP	2.	MIXTURE	232.8800	7.2718	3.1041	9.8357	(	32)
SPAC	3.	9 CM SPACING	281.0000	10.8750	4.1883	17.3830	(	24)
COMP	2.	MIXTURE	281.0000	10.8750	4.1883	17.3830	(	24)
SPAC	4.	44 PLANTS M	432.5399	14.4180	5.4080	29.2488	(	30)
COMP	2.	MIXTURE	432.5399	14.4180	5.4080	29.2488	(	30)
SPAC	5.	28 PLANTS M	440.8899	24.4928	8.5789	43.2553	(	16)
COMP	2.	MIXTURE	440.8899	24.4928	8.5789	43.2553	(	16)
SPAC	6.	17 PLANTS M	859.0599	28.8548	12.8021	166.4838	(	23)
COMP	2.	MIXTURE	859.0599	28.8548	12.8021	166.4838	(	23)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	843.4888	29.0859	11.7049	137.0054	(28)
COMP	2.	MIXTURE	843.4888	29.0859	11.7049	137.0054	(28)
TOTAL CASES =	1080						
MISSING CASES =	45 OR	4.2 PCT.					

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FILE WP77 (CREATION DATE = 03/18/82)

CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			381302.0000	350.0988	312.3584	97588.5101	(1032)
CUL	2.	GLENLEA	72338.0000	405.3820	377.8956	142853.9549	(178)
SPAC	1.	204 PLANTS M	3557.0000	154.8522	134.2100	18012.3281	(23)
COMP	1.	MONOCULTURE	1763.0000	180.2727	174.4758	30441.8182	(11)
COMP	2.	MIXTURE	1794.0000	148.5000	91.0478	8289.7273	(12)
SPAC	2.	3 CM SPACING	5288.0000	155.8588	54.8710	2988.9207	(34)
COMP	1.	MONOCULTURE	1845.0000	142.0000	57.8158	3342.6887	(13)
COMP	2.	MIXTURE	3443.0000	183.9524	82.2747	2732.6478	(21)
SPAC	3.	9 CM SPACING	7080.0000	202.6714	78.2817	5858.8403	(38)
COMP	1.	MONOCULTURE	2291.0000	178.2308	73.3134	5374.6590	(13)
COMP	2.	MIXTURE	4789.0000	218.1384	73.8441	5423.4897	(22)
SPAC	4.	44 PLANTS M	9353.0000	334.0367	88.4599	9303.7394	(28)
COMP	1.	MONOCULTURE	4405.0000	338.8482	88.3185	4887.1410	(13)
COMP	2.	MIXTURE	4948.0000	328.8887	117.8085	13902.4098	(18)
SPAC	5.	28 PLANTS M	10884.0000	534.2000	205.1432	42083.7474	(20)
COMP	1.	MONOCULTURE	7045.0000	489.8887	178.0820	32073.9824	(15)
COMP	2.	MIXTURE	3839.0000	727.8000	188.8528	25170.7000	(5)
SPAC	6.	17 PLANTS M	14580.0000	767.8947	303.3721	92034.8550	(19)
COMP	1.	MONOCULTURE	8855.0000	737.8187	242.8192	58981.1742	(12)
COMP	2.	MIXTURE	5725.0000	818.2867	403.8934	163129.8048	(7)
SPAC	7.	10 PLANTS M	21773.0000	1148.9474	438.1811	191885.1637	(18)
COMP	1.	MONOCULTURE	8984.0000	870.6000	295.1510	87705.4288	(8)

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CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
CONP	2.	MIXTURE	14808.0000	1348.2727	422.4848	178338.2182	(11)
CUL	3.	PARK	58013.0000	270.5842	171.7888	29500.3200	(207)
SPAC	1.	204 PLANTS M	2885.0000	118.8000	88.7324	3448.8000	(25)
COMP	1.	MONOCULTURE	877.0000	112.8333	89.8788	3548.3887	(8)
COMP	2.	MIXTURE	2318.0000	122.0000	89.8342	3882.1111	(18)
SPAC	2.	3 CM SPACING	8930.0000	144.8341	80.3772	8480.4878	(41)
COMP	1.	MONOCULTURE	2488.0000	178.1428	72.0233	5187.3828	(14)
COMP	2.	MIXTURE	3484.0000	128.2853	80.8218	8833.7880	(27)
SPAC	3.	9 CM SPACING	8788.0000	212.3780	82.1771	8782.0808	(32)
COMP	1.	MONOCULTURE	2837.0000	244.7800	80.0830	8118.7800	(12)
COMP	2.	MIXTURE	3888.0000	182.8800	72.8248	8288.8388	(20)
SPAC	4.	44 PLANTS M	7888.0000	288.1788	124.8308	15807.8338	(28)
COMP	1.	MONOCULTURE	3188.0000	288.8182	131.4418	17278.8838	(11)
COMP	2.	MIXTURE	4830.0000	284.1178	124.8484	18838.7382	(17)
SPAC	5.	28 PLANTS M	11878.0000	388.1724	127.1740	18172.2182	(28)
COMP	1.	MONOCULTURE	8701.0000	380.8887	132.4372	17838.8381	(18)
COMP	2.	MIXTURE	8878.0000	418.8428	122.7738	18072.3242	(14)
SPAC	6.	17 PLANTS M	10847.0000	408.8000	200.3822	40148.0800	(28)
COMP	1.	MONOCULTURE	8817.0000	432.0788	188.8128	28788.4102	(13)
COMP	2.	MIXTURE	8830.0000	388.8231	231.8878	83782.7438	(12)
SPAC	7.	10 PLANTS M	10084.0000	387.8482	187.8848	39087.3384	(28)
COMP	1.	MONOCULTURE	4887.0000	388.0000	208.3287	43817.8887	(13)
COMP	2.	MIXTURE	8417.0000	418.8822	188.1288	38788.7308	(12)
CUL	4.	70M009002	38401.0000	282.1782	184.2888	37747.2414	(128)
SPAC	1.	204 PLANTS M	2380.0000	117.8000	83.8488	2810.4737	(20)
COMP	2.	MIXTURE	2380.0000	117.8000	83.8488	2810.4737	(20)
SPAC	2.	3 CM SPACING	3173.0000	144.2272	81.8271	3787.8882	(22)
COMP	2.	MIXTURE	3173.0000	144.2272	81.8271	3787.8882	(22)

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CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	8 CM SPACING	4588.0000	227.8000	122.2488	14844.2737	(20)
COMP	2.	MIXTURE	4588.0000	227.8000	122.2488	14844.2737	(20)
SPAC	4.	44 PLANTS M	4430.0000	280.5882	117.3801	13772.3824	(17)
COMP	2.	MIXTURE	4430.0000	280.5882	117.3801	13772.3824	(17)
SPAC	5.	28 PLANTS M	7108.0000	373.8474	118.1878	13288.1837	(18)
COMP	2.	MIXTURE	7108.0000	373.8474	118.1878	13288.1837	(18)
SPAC	6.	17 PLANTS M	8782.0000	438.1000	174.4188	30422.3082	(20)
COMP	2.	MIXTURE	8782.0000	438.1000	174.4188	30422.3082	(20)
SPAC	7.	10 PLANTS M	8008.0000	548.8081	304.8132	92872.0808	(11)
COMP	2.	MIXTURE	8008.0000	548.8081	304.8132	92872.0808	(11)
CUL	5.	NDROUAY	40448.0000	278.9378	281.7088	78388.7382	(145)
SPAC	1.	204 PLANTS M	4082.0000	118.8142	78.7028	8882.3180	(25)
COMP	1.	MONOCULTURE	1888.0000	124.8878	48.7844	2377.8828	(18)
COMP	2.	MIXTURE	2087.0000	110.3884	88.0387	9032.3887	(18)
SPAC	2.	3 CM SPACING	3212.0000	182.8824	88.3288	7801.8478	(21)
COMP	1.	MONOCULTURE	1782.0000	188.1111	107.0784	11488.3811	(8)
COMP	2.	MIXTURE	1420.0000	118.3333	82.8744	2788.8970	(12)
SPAC	3.	8 CM SPACING	3727.0000	182.0438	80.8828	3720.1344	(23)
COMP	1.	MONOCULTURE	1834.0000	183.4000	87.8808	4888.4888	(10)
COMP	2.	MIXTURE	2183.0000	188.8822	87.3038	3282.7308	(12)
SPAC	4.	44 PLANTS M	8417.0000	311.7407	188.3878	27342.1884	(27)
COMP	1.	MONOCULTURE	4082.0000	388.2727	208.8884	43488.8182	(11)
COMP	2.	MIXTURE	4388.0000	272.1878	118.8872	14301.8882	(18)
SPAC	5.	28 PLANTS M	3788.0000	318.8887	174.0838	30288.2424	(12)
COMP	1.	MONOCULTURE	3788.0000	318.8887	174.0838	30288.2424	(12)

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CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	3730.0000	466.2500	409.7022	167885.9286	(8)
COMP	1.	MONOCULTURE	3730.0000	466.2500	409.7022	167885.9286	(8)
SPAC	7.	10 PLANTS M	13480.0000	709.4737	431.8153	186484.4854	(19)
COMP	1.	MONOCULTURE	8825.0000	812.8889	339.8938	115386.1111	(9)
COMP	2.	MIXTURE	7985.0000	785.8000	802.8874	252988.2778	(10)
CUL	8.	70M008002	47021.0000	370.2441	389.0327	128904.4888	(127)
SPAC	1.	204 PLANTS M	2010.0000	111.8887	49.8480	2484.7089	(18)
COMP	2.	MIXTURE	2010.0000	111.8887	49.8480	2484.7089	(18)
SPAC	2.	3 CM SPACING	2880.0000	121.8182	55.8094	3081.2887	(22)
COMP	2.	MIXTURE	2880.0000	121.8182	55.8094	3081.2887	(22)
SPAC	3.	9 CM SPACING	2558.0000	159.8875	78.8728	6173.8958	(18)
COMP	2.	MIXTURE	2558.0000	159.8875	78.8728	6173.8958	(18)
SPAC	4.	44 PLANTS M	4087.0000	340.5833	170.7302	29148.8108	(12)
COMP	2.	MIXTURE	4087.0000	340.5833	170.7302	29148.8108	(12)
SPAC	5.	28 PLANTS M	8487.0000	380.8444	197.5280	39018.5281	(18)
COMP	2.	MIXTURE	8487.0000	380.8444	197.5280	39018.5281	(18)
SPAC	8.	17 PLANTS M	13111.0000	824.3333	428.7489	183823.0333	(21)
COMP	2.	MIXTURE	13111.0000	824.3333	428.7489	183823.0333	(21)
SPAC	7.	10 PLANTS M	18081.0000	804.0500	395.0518	156088.8921	(20)
COMP	2.	MIXTURE	18081.0000	804.0500	395.0518	156088.8921	(20)
CUL	7.	NDROUAY	28828.0000	458.8482	318.8438	101881.3822	(65)
SPAC	1.	204 PLANTS M	1118.0000	138.8000	88.8280	4425.7143	(8)
COMP	2.	MIXTURE	1118.0000	138.8000	88.8280	4425.7143	(8)
SPAC	3.	3 CM SPACING	2334.0000	212.1818	128.1728	16919.8838	(11)
COMP	1.	MONOCULTURE	1477.0000	246.1887	187.8891	24882.8887	(8)

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CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	887.0000	171.4000	89.2853	4788.3000	(8)
SPAC	3.	9 CM SPACING	1731.0000	288.5000	152.7882	23337.8000	(8)
COMP	1.	MONOCULTURE	1731.0000	288.5000	152.7882	23337.8000	(8)
SPAC	4.	44 PLANTS M	2310.0000	385.0000	158.8770	24810.4000	(8)
COMP	1.	MONOCULTURE	2310.0000	385.0000	158.8770	24810.4000	(8)
SPAC	5.	28 PLANTS M	4872.0000	557.4286	140.1914	19853.8190	(7)
COMP	2.	MIXTURE	4872.0000	557.4286	140.1914	19853.8190	(7)
SPAC	8.	17 PLANTS M	8481.0000	583.4000	232.8428	84122.8428	(18)
COMP	2.	MIXTURE	8481.0000	583.4000	232.8428	84122.8428	(18)
SPAC	7.	10 PLANTS M	8211.0000	787.8833	415.2190	172405.8108	(12)
COMP	1.	MONOCULTURE	8107.0000	851.1887	473.4175	224124.1887	(8)
COMP	2.	MIXTURE	4104.0000	884.0000	372.0289	138404.0000	(8)
CUL	8.	ND701	78280.0000	437.8008	371.4790	137898.8878	(181)
SPAC	1.	204 PLANTS M	4447.0000	177.8800	51.8898	2702.8433	(25)
COMP	2.	MIXTURE	4447.0000	177.8800	51.8898	2702.8433	(25)
SPAC	2.	3 CM SPACING	8428.0000	189.8883	71.8598	5183.7813	(32)
COMP	3.	MIXTURE	8428.0000	189.8883	71.8598	5183.7813	(32)
SPAC	3.	9 CM SPACING	8083.0000	282.8280	100.8884	10133.7228	(24)
COMP	2.	MIXTURE	8083.0000	282.8280	100.8884	10133.7228	(24)
SPAC	4.	44 PLANTS M	10537.0000	351.2333	133.2888	17757.8402	(30)
COMP	2.	MIXTURE	10537.0000	351.2333	133.2888	17757.8402	(30)
SPAC	5.	28 PLANTS M	11148.0000	819.3889	217.8087	47353.8488	(18)
COMP	2.	MIXTURE	11148.0000	819.3889	217.8087	47353.8488	(18)
SPAC	8.	17 PLANTS M	17181.0000	747.4348	378.1805	143005.3478	(23)
COMP	2.	MIXTURE	17181.0000	747.4348	378.1805	143005.3478	(23)

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CRITERION VARIABLE NK								
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
SPAC	7.	10 PLANTS M	24444.0000	842.8998	511.3037	261431.4532	(	28)
COMP	2.	MIXTURE	24444.0000	842.8998	511.3037	261431.4532	(	28)
TOTAL CASES =		1080						
MISSING CASES =		48 OR	4.4 PCT.					

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FILE WP77		(CREATION DATE = 03/16/82)						
CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS						
BROKEN DOWN BY		EL	EXTRUSION LENGTH CM					
BY		CUL	CULTIVAR					
BY		SPAC	INTER-PLANT SPACING					
BY		COMP	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
FOR ENTIRE POPULATION			61344.0000	58.5344	12.5078	156.4459	(1048)	
CUL	2.	GLENLEA	13120.0000	72.0879	9.1539	83.7933	(182)	
SPAC	1.	204 PLANTS M	1782.0000	73.4167	9.8035	98.0797	(24)	
COMP	1.	MONOCULTURE	817.0000	74.2727	7.8132	62.6182	(11)	
COMP	2.	MIXTURE	965.0000	72.6923	11.8002	134.5641	(13)	
SPAC	2.	3 CM SPACING	2882.0000	73.7714	8.0040	64.0639	(35)	
COMP	1.	MONOCULTURE	1018.0000	72.5714	11.8137	134.8791	(14)	
COMP	2.	MIXTURE	1868.0000	74.5714	4.4223	19.5571	(21)	
SPAC	3.	8 CM SPACING	2534.0000	72.4000	10.9442	119.7785	(35)	
COMP	1.	MONOCULTURE	943.0000	72.5385	13.6114	185.2892	(13)	
COMP	2.	MIXTURE	1591.0000	72.3182	9.3828	88.0388	(22)	
SPAC	4.	44 PLANTS M	2084.0000	71.8521	10.3120	106.3374	(28)	
COMP	1.	MONOCULTURE	957.0000	74.2846	10.5784	111.9231	(13)	
COMP	2.	MIXTURE	1117.0000	69.8128	9.9480	98.9629	(16)	
SPAC	5.	28 PLANTS M	1418.0000	70.8000	7.5016	56.2737	(20)	
COMP	1.	MONOCULTURE	1088.0000	71.0887	7.2851	52.7810	(15)	
COMP	2.	MIXTURE	330.0000	70.0000	9.0277	81.5000	(5)	
SPAC	6.	17 PLANTS M	1424.0000	71.2000	5.7715	45.8526	(20)	
COMP	1.	MONOCULTURE	929.0000	72.2308	5.7842	48.0266	(13)	
COMP	2.	MIXTURE	495.0000	69.2857	6.6243	48.5714	(7)	
SPAC	7.	10 PLANTS M	1318.0000	69.3884	8.8394	78.1345	(19)	
COMP	1.	MONOCULTURE	857.0000	70.8750	8.9513	80.1250	(8)	

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	751.0000	58.2727	9.0232	81.4182	(11)
CUL	3.	PARK	11307.0000	54.8232	8.8587	47.0418	(207)
SPAC	1.	204 PLANTS M	1444.0000	57.7800	4.8501	23.5233	(28)
COMP	1.	MONOCULTURE	351.0000	58.8000	3.7263	13.8000	(5)
COMP	2.	MIXTURE	1093.0000	57.8253	5.2214	27.3532	(18)
SPAC	2.	3 CM SPACING	3257.0000	55.0488	7.8840	58.7878	(41)
COMP	1.	MONOCULTURE	788.0000	58.3571	7.8219	58.0834	(14)
COMP	2.	MIXTURE	1468.0000	54.3704	7.7487	60.0114	(27)
SPAC	3.	9 CM SPACING	1852.0000	57.8750	8.8098	48.3710	(32)
COMP	1.	MONOCULTURE	710.0000	59.1887	5.0422	25.4242	(12)
COMP	2.	MIXTURE	1142.0000	57.1000	7.8878	58.2528	(20)
SPAC	4.	44 PLANTS M	1808.0000	53.8829	4.7848	22.8881	(28)
COMP	1.	MONOCULTURE	808.0000	55.0000	5.0784	25.8000	(11)
COMP	2.	MIXTURE	904.0000	53.1788	4.8130	21.2784	(17)
SPAC	5.	28 PLANTS M	1584.0000	53.8882	5.2612	27.8798	(29)
COMP	1.	MONOCULTURE	808.0000	53.9323	5.4872	29.7810	(18)
COMP	2.	MIXTURE	745.0000	53.2143	5.2208	27.2582	(14)
SPAC	6.	17 PLANTS M	1345.0000	51.7308	4.2828	58.8048	(28)
COMP	1.	MONOCULTURE	880.0000	50.7882	4.4474	71.3580	(13)
COMP	2.	MIXTURE	885.0000	52.8823	5.3408	59.5541	(13)
SPAC	7.	10 PLANTS M	1348.0000	51.7882	5.8077	48.3448	(28)
COMP	1.	MONOCULTURE	873.0000	51.7882	4.3582	69.8590	(13)
COMP	2.	MIXTURE	873.0000	51.7882	5.1888	38.8523	(13)
CUL	4.	TOMORROW	8027.0000	51.2748	8.0639	52.1847	(131)
SPAC	1.	204 PLANTS M	80.8800	50.8800	5.3588	57.8078	(20)
COMP	2.	MIXTURE	1213.0000	50.8800	5.3588	57.8078	(20)
SPAC	2.	3 CM SPACING	1823.0000	58.2174	8.0451	54.7233	(23)
COMP	2.	MIXTURE	1823.0000	58.2174	8.0451	54.7233	(23)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	1228.0000	51.4000	11.8117	139.8188	(20)
COMP	2.	MIXTURE	1228.0000	51.4000	11.8117	139.8188	(20)
SPAC	4.	44 PLANTS M	1083.0000	52.5284	11.0120	121.2847	(17)
COMP	2.	MIXTURE	1083.0000	52.5284	11.0120	121.2847	(17)
SPAC	5.	28 PLANTS M	1188.0000	52.4211	5.9378	35.2573	(18)
COMP	2.	MIXTURE	1188.0000	52.4211	5.9378	35.2573	(18)
SPAC	6.	17 PLANTS M	1171.0000	58.8500	5.8513	32.0800	(20)
COMP	2.	MIXTURE	1171.0000	58.8500	5.8513	32.0800	(20)
SPAC	7.	10 PLANTS M	843.0000	53.8823	5.0174	25.1742	(12)
COMP	2.	MIXTURE	843.0000	53.8823	5.0174	25.1742	(12)
CUL	8.	NORWAY	8411.0000	44.2138	8.8978	80.9809	(145)
SPAC	1.	204 PLANTS M	1584.0000	44.4000	7.8788	53.8588	(38)
COMP	1.	MONOCULTURE	704.0000	44.0000	4.7749	22.8000	(18)
COMP	2.	MIXTURE	880.0000	44.7388	10.0490	100.9825	(19)
SPAC	2.	3 CM SPACING	1031.0000	48.8538	11.0982	123.1710	(22)
COMP	1.	MONOCULTURE	488.0000	48.8000	10.8524	118.8558	(10)
COMP	2.	MIXTURE	543.0000	48.2500	11.4348	130.7500	(12)
SPAC	3.	9 CM SPACING	1022.0000	44.4348	11.2182	125.8024	(23)
COMP	1.	MONOCULTURE	395.0000	39.8000	7.0277	49.3888	(10)
COMP	2.	MIXTURE	627.0000	48.2308	12.6578	187.6823	(13)
SPAC	4.	44 PLANTS M	1181.0000	45.8077	9.3187	88.8015	(26)
COMP	1.	MONOCULTURE	422.0000	42.2000	5.4732	29.8558	(10)
COMP	2.	MIXTURE	789.0000	48.0825	10.5111	112.8988	(18)
SPAC	5.	28 PLANTS M	485.0000	40.8000	4.7001	22.0909	(12)
COMP	1.	MONOCULTURE	485.0000	40.8000	4.7001	22.0909	(12)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC COMP	8. 1.	17 PLANTS M MONOCULTURE	308.0000 308.0000	38.2500 38.2500	8.5182 8.5182	42.8000 42.8000	(8)
SPAC COMP COMP	7. 1. 2.	10 PLANTS M MONOCULTURE MIXTURE	821.0000 375.0000 446.0000	43.2108 41.8887 44.8000	8.3898 2.9880 8.2427	40.8832 8.7500 89.8000	(8) (10)
CUL SPAC COMP	8. 1. 2.	70M008002 204 PLANTS M MIXTURE	8785.0000 875.0000 875.0000	51.7938 54.1887 54.1887	8.2288 8.2184 8.2184	38.7887 87.8888 87.8888	(131) (18)
SPAC COMP	2. 2.	3 CM SPACING MIXTURE	1138.0000 1138.0000	51.8809 51.8809	7.1757 7.1757	51.4812 51.4812	(22)
SPAC COMP	3. 2.	9 CM SPACING MIXTURE	889.0000 889.0000	53.2778 53.2778	4.7378 4.7378	22.4477 22.4477	(18)
SPAC COMP	4. 2.	44 PLANTS M MIXTURE	885.0000 885.0000	57.0833 57.0833	4.2310 4.2310	17.8018 17.8018	(12)
SPAC COMP	5. 2.	28 PLANTS M MIXTURE	889.0000 889.0000	48.2778 48.2778	4.1841 4.1841	17.8088 17.8088	(18)
SPAC COMP	8. 2.	17 PLANTS M MIXTURE	1084.0000 1084.0000	48.7273 48.7273	8.8331 8.8331	31.7318 31.7318	(22)
SPAC COMP	7. 2.	10 PLANTS M MIXTURE	1088.0000 1088.0000	50.8571 50.8571	4.7884 4.7884	22.9388 22.9388	(21)
CUL SPAC COMP	7. 1. 2.	NDROUAY 204 PLANTS M MIXTURE	3418.0000 482.0000 482.0000	49.8382 51.3333 51.3333	8.7512 8.0418 8.0418	33.0788 38.8000 38.8000	(8) (8)
SPAC COMP	2. 1.	3 CM SPACING MONOCULTURE	812.0000 311.0000	51.0000 51.8333	4.4721 3.9200	20.0000 15.3887	(12)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	301.0000	50.1887	8.1828	28.8887	(8)
SPAC COMP	3. 1.	8 CM SPACING MONOCULTURE	288.0000 288.0000	48.0000 48.0000	3.8332 3.8332	13.2000 13.2000	(8)
SPAC COMP	4. 1.	44 PLANTS M MONOCULTURE	389.0000 389.0000	51.2857 51.2857	7.1348 7.1348	50.8048 50.8048	(7)
SPAC COMP	5. 2.	28 PLANTS M MIXTURE	411.0000 411.0000	51.3750 51.3750	8.0128 8.0128	28.1280 28.1280	(8)
SPAC COMP	6. 2.	17 PLANTS M MIXTURE	733.0000 733.0000	48.8887 48.8887	5.8418 5.8418	34.1238 34.1238	(15)
SPAC COMP COMP	7. 1. 2.	10 PLANTS M MONOCULTURE MIXTURE	553.0000 278.0000 278.0000	48.0833 48.3333 48.3333	8.3898 8.7725 8.6549	40.4470 48.8887 42.8887	(12) (8)
CUL SPAC COMP	8. 1. 2.	NE701 204 PLANTS M MIXTURE	12278.0000 1848.0000 1848.0000	87.0820 73.8800 73.8800	9.8879 7.8184 7.8184	93.8888 58.0400 58.0400	(183) (25)
SPAC COMP	2. 2.	3 CM SPACING MIXTURE	2323.0000 2323.0000	72.8938 72.8938	8.8788 8.8788	73.8383 73.8383	(32)
SPAC COMP	3. 2.	9 CM SPACING MIXTURE	1881.0000 1881.0000	89.2083 89.2083	8.2888 8.2888	88.1721 88.1721	(24)
SPAC COMP	4. 2.	44 PLANTS M MIXTURE	2084.0000 2084.0000	88.8808 88.8808	12.8388 12.8388	184.7848 184.7848	(31)
SPAC COMP	5. 2.	28 PLANTS M MIXTURE	1184.0000 1184.0000	85.7778 85.7778	6.9888 6.9888	38.8301 38.8301	(18)
SPAC COMP	8. 2.	17 PLANTS M MIXTURE	1481.0000 1481.0000	81.7083 81.7083	5.8717 5.8717	34.4784 34.4784	(24)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1714.0000	59.1034	4.8386	23.3818	(28)
COMP	2.	MIXTURE	1714.0000	59.1034	4.8386	23.3818	(28)
TOTAL CASES =	1080						
MISSING CASES =	32 OR	3.0 PCT.					

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FILE WP77 (CREATION DATE = 03/18/82)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE KH
BROKEN DOWN BY CUL
BY SPAC
BY COMP

NUMBER OF KERNELS PER HEAD
CULTIVAR
INTER-PLANT SPACING
TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			48596.7801	47.2272	30.0464	902.7881	(1029)
CUL	2.	CLENLEA	7881.6181	43.1848	17.4313	303.8810	(178)
SPAC	1.	204 PLANTS M	821.8777	35.7338	10.9788	120.8301	(23)
COMP	1.	MONOCULTURE	380.3187	34.8742	14.6880	216.8784	(11)
COMP	2.	MIXTURE	441.5511	36.7968	8.5124	42.4118	(12)
SPAC	2.	3 CM SPACING	1200.7281	35.3155	7.8348	61.3808	(34)
COMP	1.	MONOCULTURE	408.7738	31.5211	7.8535	61.6781	(13)
COMP	2.	MIXTURE	790.9523	37.8844	7.0085	49.1194	(21)
SPAC	3.	8 CM SPACING	1301.4760	37.1850	9.2085	84.7800	(35)
COMP	1.	MONOCULTURE	423.0904	32.8484	9.8363	35.2402	(13)
COMP	2.	MIXTURE	878.3858	39.9266	9.7825	95.8934	(22)
SPAC	4.	44 PLANTS M	1173.9508	41.9268	8.8402	78.1480	(28)
COMP	1.	MONOCULTURE	518.1222	39.8858	3.0789	9.4798	(13)
COMP	2.	MIXTURE	655.8287	43.7219	11.8258	138.1542	(18)
SPAC	5.	28 PLANTS M	916.8982	45.7949	8.3218	89.2518	(20)
COMP	1.	MONOCULTURE	881.8582	45.4572	8.8754	78.7724	(15)
COMP	2.	MIXTURE	234.0400	46.8080	7.1788	61.8324	(8)
SPAC	6.	17 PLANTS M	1078.4954	55.7829	18.8803	348.2073	(19)
COMP	1.	MONOCULTURE	887.3883	48.9490	12.1367	147.2890	(12)
COMP	2.	MIXTURE	491.1071	70.1582	21.0805	443.1220	(7)
SPAC	7.	10 PLANTS M	1189.0837	62.8838	34.1988	1189.8233	(18)
COMP	1.	MONOCULTURE	352.3312	44.0414	14.3582	208.1591	(8)

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CRITERION VARIABLE KM

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	539.7829	78.0893	28.8478	1488.9088	(11)
CUL	3.	PARK	8871.1043	41.8073	18.4078	337.3988	(206)
SPAC	1.	204 PLANTS M	733.3737	29.3349	8.8888	73.2875	(25)
COMP	1.	MONOCULTURE	182.8187	27.1828	8.7488	33.0887	(6)
COMP	2.	MIXTURE	870.4870	30.0241	8.2882	88.4180	(19)
SPAC	2.	3 CM SPACING	1188.7334	29.7433	8.8802	73.1088	(40)
COMP	1.	MONOCULTURE	415.8107	31.8931	7.3812	84.4827	(13)
COMP	2.	MIXTURE	773.8227	28.8801	8.8888	80.7833	(27)
SPAC	3.	8 CM SPACING	1288.8828	40.2178	12.2892	181.2888	(32)
COMP	1.	MONOCULTURE	471.2182	38.2880	8.2828	39.0871	(12)
COMP	2.	MIXTURE	815.7484	40.7873	14.8420	223.2820	(20)
SPAC	4.	44 PLANTS M	1191.1323	42.8404	7.8284	81.2887	(28)
COMP	1.	MONOCULTURE	484.2373	42.2034	8.1781	38.1441	(11)
COMP	2.	MIXTURE	728.8981	42.7888	8.8148	78.4748	(17)
SPAC	5.	28 PLANTS M	1380.8783	47.8188	10.8078	112.8281	(28)
COMP	1.	MONOCULTURE	710.8834	47.3808	10.4827	108.8888	(18)
COMP	2.	MIXTURE	870.0149	47.8882	11.1314	123.8070	(14)
SPAC	8.	17 PLANTS M	1382.8421	52.4088	18.0880	289.1788	(28)
COMP	1.	MONOCULTURE	878.8418	52.2724	10.8000	118.8404	(13)
COMP	2.	MIXTURE	883.0003	52.8388	20.8738	432.2722	(13)
SPAC	7.	10 PLANTS M	1428.4820	54.8847	18.8828	388.1087	(28)
COMP	1.	MONOCULTURE	771.1832	59.3198	10.8728	120.4028	(13)
COMP	2.	MIXTURE	888.3288	50.4088	28.8087	888.8884	(13)
CUL	4.	700008003	8188.4814	40.2748	18.7844	248.2018	(128)
SPAC	1.	204 PLANTS M	848.1842	27.4082	8.4147	88.8288	(20)
COMP	2.	MIXTURE	848.1842	27.4082	8.4147	88.8288	(20)
SPAC	3.	3 CM SPACING	783.1878	38.0844	8.8288	88.8188	(22)
COMP	2.	MIXTURE	783.1878	38.0844	8.8288	88.8188	(22)

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CRITERION VARIABLE KM

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	8 CM SPACING	724.7881	38.2378	13.8308	194.0824	(20)
COMP	2.	MIXTURE	724.7881	38.2378	13.8308	194.0824	(20)
SPAC	4.	44 PLANTS M	778.3882	48.8484	21.8878	488.1732	(17)
COMP	2.	MIXTURE	778.3882	48.8484	21.8878	488.1732	(17)
SPAC	5.	28 PLANTS M	888.2087	48.8428	10.8520	117.7887	(18)
COMP	2.	MIXTURE	888.2087	48.8428	10.8520	117.7887	(18)
SPAC	8.	17 PLANTS M	1002.8302	50.1818	18.8808	388.3482	(20)
COMP	2.	MIXTURE	1002.8302	50.1818	18.8808	388.3482	(20)
SPAC	7.	10 PLANTS M	488.8088	41.8088	8.8781	73.8328	(11)
COMP	2.	MIXTURE	488.8088	41.8088	8.8781	73.8328	(11)
CUL	5.	NORQUAY	8843.3841	40.5788	18.8821	388.2831	(144)
SPAC	1.	204 PLANTS M	887.0890	28.4877	8.3878	70.8184	(38)
COMP	1.	MONOCULTURE	487.2888	31.0792	8.8848	44.4183	(18)
COMP	2.	MIXTURE	489.8023	28.3084	8.2288	88.1812	(18)
SPAC	2.	3 CM SPACING	882.3023	33.1181	11.4121	130.2382	(26)
COMP	1.	MONOCULTURE	333.4788	37.0832	11.1301	123.8781	(8)
COMP	2.	MIXTURE	328.8238	29.8831	11.0880	122.8884	(11)
SPAC	3.	8 CM SPACING	828.3918	38.0170	8.3718	70.0880	(23)
COMP	1.	MONOCULTURE	388.8280	38.8828	7.8852	88.2188	(10)
COMP	2.	MIXTURE	482.8888	38.8820	8.1440	83.8138	(13)
SPAC	4.	44 PLANTS M	1088.7240	40.8184	14.0708	187.8900	(27)
COMP	1.	MONOCULTURE	481.1217	43.7383	14.8272	223.1211	(11)
COMP	2.	MIXTURE	815.8023	38.4781	13.8084	182.3872	(18)
SPAC	8.	28 PLANTS M	880.1883	48.8828	13.0782	171.0842	(12)
COMP	1.	MONOCULTURE	880.1883	48.8828	13.0782	171.0842	(12)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	413.3508	51.6668	13.4005	179.8738	(8)
COMP	1.	MONOCULTURE	413.3508	51.6668	13.4005	179.8738	(8)
SPAC	7.	10 PLANTS M	1285.3313	87.8480	33.8088	1129.8200	(18)
COMP	1.	MONOCULTURE	499.8719	55.3080	10.3885	107.8584	(8)
COMP	2.	MIXTURE	785.4594	78.8759	43.3970	1883.2974	(10)
CUL	8.	70M008002	8878.4120	84.1807	37.5907	1413.0803	(127)
SPAC	1.	204 PLANTS M	897.2833	33.1824	10.1885	103.1845	(18)
COMP	2.	MIXTURE	897.2833	33.1824	10.1885	103.1845	(18)
SPAC	2.	3 CM SPACING	700.2285	31.8288	12.2808	150.8180	(22)
COMP	2.	MIXTURE	700.2285	31.8288	12.2808	150.8180	(22)
SPAC	3.	9 CM SPACING	845.1880	40.3243	18.8801	284.8387	(18)
COMP	2.	MIXTURE	845.1880	40.3243	18.8801	284.8387	(18)
SPAC	4.	44 PLANTS M	808.8874	80.8498	10.8921	114.3218	(12)
COMP	2.	MIXTURE	808.8874	80.8498	10.8921	114.3218	(12)
SPAC	5.	28 PLANTS M	1071.9321	59.5518	28.4828	701.3251	(18)
COMP	2.	MIXTURE	1071.9321	59.5518	28.4828	701.3251	(18)
SPAC	8.	17 PLANTS M	1489.1852	89.9812	44.2788	1980.8712	(21)
COMP	2.	MIXTURE	1489.1852	89.9812	44.2788	1980.8712	(21)
SPAC	7.	10 PLANTS M	1787.9973	89.3999	57.8211	3354.8808	(20)
COMP	2.	MIXTURE	1787.9973	89.3999	57.8211	3354.8808	(20)
CUL	7.	NORQUAY	3758.2950	57.8189	40.0828	1804.2071	(88)
SPAC	1.	204 PLANTS M	248.0833	30.7804	8.3488	89.7181	(8)
COMP	2.	MIXTURE	248.0833	30.7804	8.3488	89.7181	(8)
SPAC	2.	3 CM SPACING	438.8273	39.8843	12.1837	147.7128	(11)
COMP	1.	MONOCULTURE	278.7063	48.1181	11.8580	143.0170	(8)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	189.8190	31.9638	7.3428	83.8133	(8)
SPAC	3.	9 CM SPACING	330.8278	55.0880	18.8008	243.3890	(8)
COMP	1.	MONOCULTURE	330.8278	55.0880	18.8008	243.3890	(8)
SPAC	4.	44 PLANTS M	328.4289	54.7378	15.2788	233.4748	(8)
COMP	1.	MONOCULTURE	328.4289	54.7378	15.2788	233.4748	(8)
SPAC	5.	28 PLANTS M	398.9833	59.9978	17.3478	300.9489	(7)
COMP	2.	MIXTURE	398.9833	59.9978	17.3478	300.9489	(7)
SPAC	8.	17 PLANTS M	1088.8884	70.8904	35.8580	4297.4813	(18)
COMP	2.	MIXTURE	1088.8884	70.8904	35.8580	4297.4813	(18)
SPAC	7.	10 PLANTS M	858.8888	78.9075	40.8732	1878.8088	(12)
COMP	1.	MONOCULTURE	863.8800	93.8250	48.9734	2208.4971	(8)
COMP	2.	MIXTURE	395.3389	55.8900	31.8837	1015.2882	(8)
CUL	8.	N8701	10888.8183	59.2701	48.8441	2203.7482	(180)
SPAC	1.	204 PLANTS M	1088.0888	43.8840	7.1817	81.2901	(28)
COMP	2.	MIXTURE	1088.0888	43.8840	7.1817	81.2901	(28)
SPAC	2.	3 CM SPACING	1291.4118	41.8584	8.8718	73.4757	(31)
COMP	2.	MIXTURE	1291.4118	41.8584	8.8718	73.4757	(31)
SPAC	3.	9 CM SPACING	1105.2297	48.0512	7.8978	82.3728	(24)
COMP	2.	MIXTURE	1105.2297	48.0512	7.8978	82.3728	(24)
SPAC	4.	44 PLANTS M	1883.7350	53.1245	17.5118	308.8880	(30)
COMP	2.	MIXTURE	1883.7350	53.1245	17.5118	308.8880	(30)
SPAC	5.	28 PLANTS M	1028.4320	57.0240	14.1838	200.8088	(18)
COMP	2.	MIXTURE	1028.4320	57.0240	14.1838	200.8088	(18)
SPAC	8.	17 PLANTS M	1700.7707	73.9488	38.8588	1288.8588	(23)
COMP	2.	MIXTURE	1700.7707	73.9488	38.8588	1288.8588	(23)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	2851.9381	88.8878	88.8067	8821.2822	(29)
COMP	2.	MIXTURE	2851.9381	88.8878	88.8067	8821.2822	(29)
TOTAL CASES =	1080						
MISSING CASES =	81 OR	4.7 PCT.					

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FILE WP77 (CREATION DATE = 03/16/82)

----- DESCRIPTION OF SUBPOPULATIONS -----
 CRITERION VARIABLE YH SEED YIELD PER HEAD G
 BROKEN DOWN BY CUL CULTIVAR
 BY SPAC INTER-PLANT SPACING
 BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1988.0893	1.8071	1.0328	1.0662	(1032)
CUL	2.	GLENLEA	385.0532	2.1392	0.8522	0.7262	(180)
SPAC	1.	204 PLANTS M	41.8094	1.8178	0.4814	0.2317	(23)
COMP	1.	MONOCULTURE	18.8428	1.7221	0.8848	0.7720	(11)
COMP	2.	MIXTURE	22.8669	1.9055	0.3873	0.1499	(12)
SPAC	2.	3 CM SPACING	80.8771	1.7805	0.4431	0.1963	(34)
COMP	1.	MONOCULTURE	20.8358	1.5874	0.4884	0.2375	(13)
COMP	2.	MIXTURE	40.2418	1.9182	0.3872	0.1499	(21)
SPAC	3.	9 CM SPACING	85.8227	1.8748	0.5280	0.2788	(38)
COMP	1.	MONOCULTURE	20.8213	1.5766	0.4082	0.1668	(13)
COMP	2.	MIXTURE	45.1013	2.0801	0.5210	0.2714	(22)
SPAC	4.	44 PLANTS M	80.3123	2.0797	0.5411	0.2928	(29)
COMP	1.	MONOCULTURE	28.8183	1.8708	0.2088	0.0422	(13)
COMP	2.	MIXTURE	34.8980	2.1885	0.7028	0.4940	(18)
SPAC	5.	28 PLANTS M	43.8273	2.1814	0.4073	0.1659	(20)
COMP	1.	MONOCULTURE	32.8089	2.1871	0.4180	0.1758	(15)
COMP	2.	MIXTURE	11.3214	2.2843	0.4088	0.1685	(5)
SPAC	6.	17 PLANTS M	54.5802	2.7280	0.8971	0.8047	(20)
COMP	1.	MONOCULTURE	31.4904	2.4223	0.8282	0.6861	(13)
COMP	2.	MIXTURE	23.0898	2.2987	1.2158	1.4783	(7)
SPAC	7.	10 PLANTS M	58.0442	3.0580	1.8421	3.3984	(18)
COMP	1.	MONOCULTURE	17.8888	2.2381	0.7544	0.5691	(8)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	40.1858	3.8508	1.8784	3.5288	(11)
CUL	3.	PARK	304.1484	1.4788	0.8188	0.2899	(208)
SPAC	1.	204 PLANTS M	27.4428	1.0977	0.3843	0.1328	(28)
COMP	1.	MONOCULTURE	8.8233	0.8722	0.2392	0.0888	(8)
COMP	2.	MIXTURE	21.8093	1.1373	0.3832	0.1548	(18)
SPAC	2.	3 CM SPACING	43.6308	1.0808	0.3884	0.1338	(40)
COMP	1.	MONOCULTURE	18.4830	1.1818	0.3392	0.1161	(13)
COMP	2.	MIXTURE	28.1378	1.0421	0.3737	0.1398	(27)
SPAC	3.	8 CM SPACING	48.4758	1.4211	0.4347	0.1880	(32)
COMP	1.	MONOCULTURE	18.3301	1.3808	0.2223	0.0494	(12)
COMP	2.	MIXTURE	28.1458	1.4573	0.5284	0.2781	(20)
SPAC	4.	44 PLANTS M	43.8841	1.5701	0.3528	0.1243	(28)
COMP	1.	MONOCULTURE	18.3184	1.4833	0.3848	0.1481	(11)
COMP	2.	MIXTURE	27.8478	1.8263	0.3297	0.1087	(17)
SPAC	5.	28 PLANTS M	48.4482	1.8705	0.3998	0.1587	(28)
COMP	1.	MONOCULTURE	24.2838	1.8188	0.4481	0.2008	(18)
COMP	2.	MIXTURE	24.1814	1.7280	0.3478	0.1208	(14)
SPAC	6.	17 PLANTS M	48.7801	1.7892	0.6087	0.2887	(28)
COMP	1.	MONOCULTURE	22.8780	1.8443	0.3773	0.1423	(13)
COMP	2.	MIXTURE	22.8041	1.7842	0.8213	0.3880	(13)
SPAC	7.	10 PLANTS M	48.4108	1.8619	0.8104	0.3728	(28)
COMP	1.	MONOCULTURE	28.8712	1.8747	0.3184	0.1020	(13)
COMP	2.	MIXTURE	22.7384	1.7482	0.8041	0.6488	(13)
CUL	4.	70M008002	184.8818	1.4332	0.8448	0.2888	(128)
SPAC	1.	204 PLANTS M	18.3881	0.8893	0.3434	0.1178	(20)
COMP	2.	MIXTURE	18.3881	0.8893	0.3434	0.1178	(20)
SPAC	2.	3 CM SPACING	28.1887	1.3288	0.3877	0.1803	(22)
COMP	2.	MIXTURE	28.1887	1.3288	0.3877	0.1803	(22)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	8 CM SPACING	28.1172	1.3058	0.4493	0.2018	(20)
COMP	2.	MIXTURE	28.1172	1.3058	0.4493	0.2018	(20)
SPAC	4.	44 PLANTS M	28.3328	1.4802	0.3240	0.1080	(17)
COMP	2.	MIXTURE	28.3328	1.4802	0.3240	0.1080	(17)
SPAC	5.	28 PLANTS M	32.8414	1.7180	0.3888	0.1484	(18)
COMP	2.	MIXTURE	32.8414	1.7180	0.3888	0.1484	(18)
SPAC	6.	17 PLANTS M	38.3441	1.8172	0.8081	0.6482	(20)
COMP	2.	MIXTURE	38.3441	1.8172	0.8081	0.6482	(20)
SPAC	7.	10 PLANTS M	18.8043	1.4488	0.8110	0.2811	(11)
COMP	2.	MIXTURE	18.8043	1.4488	0.8110	0.2811	(11)
CUL	5.	NORQUAY	255.0881	1.7709	0.8038	0.6487	(144)
SPAC	1.	204 PLANTS M	48.4330	1.2881	0.3948	0.1587	(36)
COMP	1.	MONOCULTURE	22.8813	1.4383	0.3122	0.0881	(18)
COMP	2.	MIXTURE	22.4517	1.1817	0.4288	0.1811	(18)
SPAC	2.	3 CM SPACING	30.0314	1.8018	0.4878	0.2378	(20)
COMP	1.	MONOCULTURE	18.3427	1.7048	0.4888	0.2388	(8)
COMP	2.	MIXTURE	14.8877	1.3382	0.4418	0.1980	(11)
SPAC	3.	8 CM SPACING	38.8388	1.8930	0.3877	0.1280	(23)
COMP	1.	MONOCULTURE	18.8807	1.8881	0.3223	0.1038	(10)
COMP	2.	MIXTURE	19.9783	1.5388	0.3888	0.1488	(13)
SPAC	4.	44 PLANTS M	48.0092	1.7040	0.5187	0.2680	(27)
COMP	1.	MONOCULTURE	19.8947	1.8088	0.4112	0.1881	(11)
COMP	2.	MIXTURE	28.1148	1.6322	0.8831	0.3401	(18)
SPAC	5.	28 PLANTS M	24.3208	2.0287	0.4821	0.2422	(12)
COMP	1.	MONOCULTURE	24.3208	2.0287	0.4821	0.2422	(12)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	18.8488	2.3561	0.7385	0.5453	(8)
COMP	1.	MONOCULTURE	18.8488	2.3561	0.7385	0.5453	(8)
SPAC	7.	10 PLANTS M	53.7261	2.8277	1.3188	1.7418	(19)
COMP	1.	MONOCULTURE	31.0710	2.3412	0.4937	0.2437	(9)
COMP	2.	MIXTURE	32.8550	3.2885	1.8785	3.5175	(10)
CUL	8.	70M009002	289.7245	2.2825	1.4789	2.1812	(128)
SPAC	1.	204 PLANTS M	28.3803	1.4858	0.3718	0.1381	(18)
COMP	2.	MIXTURE	28.3803	1.4858	0.3718	0.1381	(18)
SPAC	2.	3 CM SPACING	31.4894	1.4300	0.5217	0.2722	(22)
COMP	2.	MIXTURE	31.4894	1.4300	0.5217	0.2722	(22)
SPAC	3.	9 CM SPACING	28.8285	1.8017	0.8002	0.6403	(18)
COMP	2.	MIXTURE	28.8285	1.8017	0.8002	0.6403	(18)
SPAC	4.	44 PLANTS M	25.8712	2.1558	0.4885	0.2387	(12)
COMP	2.	MIXTURE	25.8712	2.1558	0.4885	0.2387	(12)
SPAC	5.	28 PLANTS M	43.0823	2.3838	1.1272	1.2708	(18)
COMP	2.	MIXTURE	43.0823	2.3838	1.1272	1.2708	(18)
SPAC	6.	17 PLANTS M	81.0188	2.7735	1.7383	3.0218	(22)
COMP	2.	MIXTURE	81.0188	2.7735	1.7383	3.0218	(22)
SPAC	7.	10 PLANTS M	73.0881	3.6544	2.2555	5.0875	(20)
COMP	2.	MIXTURE	73.0881	3.6544	2.2555	5.0875	(20)
CUL	7.	NDROUAY	134.8328	2.0759	1.2823	1.6727	(85)
SPAC	1.	204 PLANTS M	9.3855	1.1733	0.1854	0.0355	(8)
COMP	2.	MIXTURE	9.3855	1.1733	0.1854	0.0355	(8)
SPAC	3.	3 CM SPACING	18.4870	1.4870	0.4180	0.1747	(11)
COMP	1.	MONOCULTURE	10.3048	1.7174	0.4135	0.1710	(8)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	3.	MIXTURE	8.1824	1.2325	0.2804	0.0827	(5)
SPAC	3.	9 CM SPACING	11.3371	1.8895	0.8081	0.6573	(6)
COMP	1.	MONOCULTURE	11.3371	1.8895	0.8081	0.6573	(6)
SPAC	4.	44 PLANTS M	11.7388	1.9581	0.4860	0.2371	(8)
COMP	1.	MONOCULTURE	11.7388	1.9581	0.4860	0.2371	(8)
SPAC	5.	28 PLANTS M	15.0878	2.1554	0.8894	0.7947	(7)
COMP	2.	MIXTURE	15.0878	2.1554	0.8894	0.7947	(7)
SPAC	6.	17 PLANTS M	38.6513	2.4434	1.8441	3.7795	(18)
COMP	2.	MIXTURE	38.6513	2.4434	1.8441	3.7795	(18)
SPAC	7.	10 PLANTS M	34.2855	2.8885	1.5594	2.4318	(12)
COMP	1.	MONOCULTURE	20.8884	3.4814	1.6761	2.8092	(8)
COMP	3.	MIXTURE	13.3782	2.2297	1.2650	1.6003	(5)
CUL	8.	NR701	414.3394	2.3019	1.2388	1.5297	(180)
SPAC	1.	204 PLANTS M	45.8512	1.8344	0.2339	0.0547	(25)
COMP	2.	MIXTURE	45.8512	1.8344	0.2339	0.0547	(25)
SPAC	2.	3 CM SPACING	55.3091	1.7842	0.3791	0.1437	(31)
COMP	2.	MIXTURE	55.3091	1.7842	0.3791	0.1437	(31)
SPAC	3.	9 CM SPACING	47.9873	1.9985	0.3191	0.1018	(24)
COMP	2.	MIXTURE	47.9873	1.9985	0.3191	0.1018	(24)
SPAC	4.	44 PLANTS M	85.4855	2.1822	0.8851	0.7832	(30)
COMP	2.	MIXTURE	85.4855	2.1822	0.8851	0.7832	(30)
SPAC	5.	28 PLANTS M	41.8559	2.3142	0.8151	0.6643	(18)
COMP	2.	MIXTURE	41.8559	2.3142	0.8151	0.6643	(18)
SPAC	6.	17 PLANTS M	64.4381	2.8018	1.1884	1.4152	(23)
COMP	2.	MIXTURE	64.4381	2.8018	1.1884	1.4152	(23)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	83.8433	3.2291	2.4648	8.0280	(39)
COMP	2.	MIXTURE	83.8433	3.2291	2.4648	8.0280	(29)
TOTAL CASES =	1080						
MISSING CASES =	48 OR	4.4 PCT.					

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(CREATION DATE = 03/18/82)

CRITERION VARIABLE	DESCRIPTION	WEIGHT PER 1000 KERNELS C
BROKEN DOWN BY	CUL	CULTIVAR
BY	SPAC	INTER-PLANT SPACING
BY	COMP	TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			42589.7974	41.2498	7.2998	53.2888	(1032)
CUL	2.	OLENLEA	8851.0077	48.7248	5.0482	25.4840	(178)
SPAC	1.	204 PLANTS M	1178.1885	51.2862	3.1204	9.7898	(23)
COMP	1.	MONOCULTURE	858.3181	50.7559	3.7874	14.4201	(11)
COMP	2.	MIXTURE	620.8634	51.7378	2.4468	5.9888	(12)
SPAC	2.	3 CM SPACING	1717.2338	50.8089	4.4477	19.7824	(34)
COMP	1.	MONOCULTURE	850.0408	50.0031	5.5828	30.8448	(13)
COMP	2.	MIXTURE	1067.2929	50.8235	3.7194	13.8041	(21)
SPAC	3.	8 CM SPACING	1755.1987	50.1495	5.7935	33.5848	(35)
COMP	1.	MONOCULTURE	821.7048	47.8234	8.8231	43.8888	(13)
COMP	2.	MIXTURE	1133.4939	51.8225	4.5941	23.8522	(22)
SPAC	4.	44 PLANTS M	1379.1382	49.2549	8.5280	42.6150	(28)
COMP	1.	MONOCULTURE	841.8000	49.3789	2.3775	5.5828	(13)
COMP	2.	MIXTURE	737.3382	49.1492	8.7929	77.3182	(15)
SPAC	5.	28 PLANTS M	955.7877	47.8399	2.1878	4.7884	(20)
COMP	1.	MONOCULTURE	715.7428	47.7162	2.2209	4.9328	(15)
COMP	2.	MIXTURE	241.0549	48.2110	2.2895	5.2419	(8)
SPAC	6.	17 PLANTS M	929.2983	48.9104	7.0853	50.2019	(19)
COMP	1.	MONOCULTURE	803.1059	50.2588	5.7754	48.9058	(12)
COMP	2.	MIXTURE	328.1924	48.5989	7.5217	56.5784	(7)
SPAC	7.	10 PLANTS M	834.0728	48.1617	3.1448	9.8884	(18)
COMP	1.	MONOCULTURE	407.8855	50.9592	3.2898	10.7851	(8)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	828.4071	47.8852	2.4048	5.7829	(11)
CUL	3.	PARK	7387.8455	35.7384	5.1982	27.0004	(207)
SPAC	1.	204 PLANTS M	929.4885	37.1785	4.8425	24.4284	(25)
COMP	1.	MONOCULTURE	212.8884	35.8997	3.2895	11.4897	(8)
COMP	2.	MIXTURE	715.8881	37.8763	5.3154	28.2850	(19)
SPAC	2.	3 CM SPACING	1485.1311	35.7349	5.5788	31.1204	(41)
COMP	1.	MONOCULTURE	488.9231	34.8231	7.5533	57.2042	(14)
COMP	2.	MIXTURE	976.2080	35.1559	4.3289	18.7385	(27)
SPAC	3.	9 CM SPACING	1137.2260	35.5383	4.9792	24.7926	(32)
COMP	1.	MONOCULTURE	420.7838	35.0628	5.3410	28.8269	(12)
COMP	2.	MIXTURE	716.4722	35.8238	4.8890	23.7071	(20)
SPAC	4.	44 PLANTS M	1033.5158	35.9113	4.8855	23.8878	(28)
COMP	1.	MONOCULTURE	383.8480	34.8951	5.9825	35.7901	(11)
COMP	2.	MIXTURE	649.6678	38.2189	3.6478	13.3050	(17)
SPAC	5.	28 PLANTS M	1031.9980	35.8787	5.5942	43.4834	(29)
COMP	1.	MONOCULTURE	521.7787	34.7882	5.7648	78.8488	(18)
COMP	2.	MIXTURE	509.8173	35.4227	3.1013	9.8183	(14)
SPAC	6.	17 PLANTS M	904.4805	34.7877	5.0839	25.8434	(28)
COMP	1.	MONOCULTURE	481.4738	35.4980	4.0248	16.1957	(13)
COMP	2.	MIXTURE	443.0069	34.0775	5.0112	35.1341	(13)
SPAC	7.	10 PLANTS M	895.2095	34.4734	3.4744	12.0714	(28)
COMP	1.	MONOCULTURE	426.1244	33.5480	2.8578	8.2243	(13)
COMP	2.	MIXTURE	469.1851	35.3989	3.8919	15.0890	(13)
CUL	4.	70M009002	4822.2841	35.8317	5.1398	26.4181	(138)
SPAC	1.	204 PLANTS M	703.2322	35.1818	5.1985	27.0247	(20)
COMP	2.	MIXTURE	703.2322	35.1818	5.1985	27.0247	(20)
SPAC	2.	3 CM SPACING	814.8532	37.0297	4.8510	20.7115	(22)
COMP	2.	MIXTURE	814.8532	37.0297	4.8510	20.7115	(22)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	728.6205	35.4310	3.5613	12.6832	(20)
COMP	2.	MIXTURE	728.6205	35.4310	3.5613	12.6832	(20)
SPAC	4.	44 PLANTS M	595.9857	35.0580	7.3110	53.4505	(17)
COMP	2.	MIXTURE	595.9857	35.0580	7.3110	53.4505	(17)
SPAC	5.	28 PLANTS M	701.9160	35.8429	2.7442	7.5308	(19)
COMP	2.	MIXTURE	701.9160	35.8429	2.7442	7.5308	(19)
SPAC	6.	17 PLANTS M	711.0827	35.8541	4.8004	23.0438	(20)
COMP	2.	MIXTURE	711.0827	35.8541	4.8004	23.0438	(20)
SPAC	7.	10 PLANTS M	386.7838	33.3449	7.8288	61.2581	(11)
COMP	2.	MIXTURE	386.7838	33.3449	7.8288	61.2581	(11)
CUL	5.	NORWAY	8398.3223	44.1264	4.8005	24.0162	(185)
SPAC	1.	204 PLANTS M	1589.8051	45.4173	3.5845	12.8483	(35)
COMP	1.	MONOCULTURE	739.4898	45.2187	2.0699	4.2878	(16)
COMP	2.	MIXTURE	850.1053	44.7424	4.4246	19.5775	(19)
SPAC	2.	3 CM SPACING	842.3787	44.8752	5.1550	26.5848	(21)
COMP	1.	MONOCULTURE	415.8354	45.1817	2.2938	5.2504	(9)
COMP	2.	MIXTURE	526.7442	43.8854	5.4859	42.0883	(12)
SPAC	3.	9 CM SPACING	1023.1318	44.8840	3.2881	10.8773	(23)
COMP	1.	MONOCULTURE	457.1795	45.7180	2.0408	4.1848	(10)
COMP	2.	MIXTURE	565.9524	43.5348	3.8175	14.5731	(13)
SPAC	4.	44 PLANTS M	1147.2085	42.4882	5.2457	39.0089	(27)
COMP	1.	MONOCULTURE	471.4551	42.8595	5.8602	48.4443	(11)
COMP	2.	MIXTURE	675.7534	42.2348	5.9287	35.1498	(18)
SPAC	5.	28 PLANTS M	529.2208	44.1017	4.0125	16.1002	(12)
COMP	1.	MONOCULTURE	529.2208	44.1017	4.0125	16.1002	(12)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	381.5848	48.1981	8.7857	48.0455	(8)
COMP	1.	MONOCULTURE	381.5848	48.1981	8.7857	48.0455	(8)
SPAC	7.	10 PLANTS M	305.1918	42.3785	5.3884	29.1215	(18)
COMP	1.	MONOCULTURE	381.2081	42.3585	5.3178	28.2797	(8)
COMP	2.	MIXTURE	423.8438	42.3894	5.7537	32.1048	(10)
CUL	8.	70M009002	8508.8012	43.3827	5.8913	32.3902	(127)
SPAC	1.	204 PLANTS M	817.0180	45.3899	9.4339	41.3948	(18)
COMP	2.	MIXTURE	817.0180	45.3899	9.4339	41.3948	(18)
SPAC	2.	3 CM SPACING	1008.1300	48.8241	4.7854	22.9000	(22)
COMP	2.	MIXTURE	1008.1300	48.8241	4.7854	22.9000	(22)
SPAC	3.	9 CM SPACING	714.0318	44.8270	5.8788	32.2483	(18)
COMP	2.	MIXTURE	714.0318	44.8270	5.8788	32.2483	(18)
SPAC	4.	44 PLANTS M	514.8788	42.8180	5.3435	28.6530	(12)
COMP	2.	MIXTURE	514.8788	42.8180	5.3435	28.6530	(12)
SPAC	5.	28 PLANTS M	727.0384	40.3909	5.9079	34.9035	(18)
COMP	2.	MIXTURE	727.0384	40.3909	5.9079	34.9035	(18)
SPAC	8.	17 PLANTS M	890.3889	42.3878	4.8588	21.6742	(21)
COMP	2.	MIXTURE	890.3889	42.3878	4.8588	21.6742	(21)
SPAC	7.	10 PLANTS M	838.0485	41.8024	5.8920	32.3884	(20)
COMP	2.	MIXTURE	838.0485	41.8024	5.8920	32.3884	(20)
CUL	7.	NORQUAY	2374.8733	38.6334	5.0738	25.7431	(85)
SPAC	1.	204 PLANTS M	312.4172	38.0821	4.1820	17.2382	(8)
COMP	2.	MIXTURE	312.4172	38.0821	4.1820	17.2382	(8)
SPAC	3.	3 CM SPACING	418.3873	38.1261	2.8215	8.8364	(11)
COMP	1.	MONOCULTURE	225.1788	37.8285	3.2048	10.2894	(8)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	184.2105	38.8421	2.7088	7.3271	(8)
SPAC	3.	9 CM SPACING	203.8732	33.9789	7.1510	81.1384	(8)
COMP	1.	MONOCULTURE	203.8732	33.9789	7.1510	81.1384	(8)
SPAC	4.	44 PLANTS M	218.8889	35.8480	5.8840	44.6757	(8)
COMP	1.	MONOCULTURE	218.8889	35.8480	5.8840	44.6757	(8)
SPAC	5.	28 PLANTS M	284.9277	37.8488	3.5307	12.4858	(7)
COMP	2.	MIXTURE	284.9277	37.8488	3.5307	12.4858	(7)
SPAC	8.	17 PLANTS M	537.0854	35.8037	4.8428	21.5583	(15)
COMP	2.	MIXTURE	537.0854	35.8037	4.8428	21.5583	(15)
SPAC	7.	10 PLANTS M	417.1427	34.7819	6.1072	37.2860	(12)
COMP	1.	MONOCULTURE	225.4385	37.5726	3.7267	13.8882	(8)
COMP	2.	MIXTURE	191.7072	31.9512	7.0148	49.2074	(8)
CUL	8.	N8701	7418.0833	40.9727	5.8890	34.4687	(181)
SPAC	1.	204 PLANTS M	1051.8588	42.4684	3.7838	14.3171	(25)
COMP	2.	MIXTURE	1051.8588	42.4684	3.7838	14.3171	(25)
SPAC	2.	3 CM SPACING	1358.1028	42.4407	5.1420	26.4404	(32)
COMP	2.	MIXTURE	1358.1028	42.4407	5.1420	26.4404	(32)
SPAC	3.	9 CM SPACING	1047.5367	43.8474	4.3314	18.7612	(24)
COMP	2.	MIXTURE	1047.5367	43.8474	4.3314	18.7612	(24)
SPAC	4.	44 PLANTS M	1237.8341	41.2545	4.2021	17.8573	(30)
COMP	2.	MIXTURE	1237.8341	41.2545	4.2021	17.8573	(30)
SPAC	5.	28 PLANTS M	733.9242	40.7738	5.0787	35.8258	(18)
COMP	2.	MIXTURE	733.9242	40.7738	5.0787	35.8258	(18)
SPAC	8.	17 PLANTS M	895.3368	38.9712	5.8575	32.0074	(23)
COMP	2.	MIXTURE	895.3368	38.9712	5.8575	32.0074	(23)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1080.8703	37.2714	8.3833	70.4478	(25)
COMP	2.	MIXTURE	1080.8703	37.2714	8.3833	70.4478	(25)
TOTAL CASES =	1080						
MISSING CASES =	48 OR	4.4 PCT.					

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(CREATION DATE = 03/18/82)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	BY	BY	BY	HARVEST INDEX	CULTIVAR	INTER-PLANT SPACING	TREATMENT
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			7090.3000	8.8771	47.8782	2273.0192	(1031)
CUL	2.	GLENLEA	885.8181	3.8314	2.0483	4.1955	(178)
SPAC	1.	204 PLANTS M	108.8488	4.8328	1.3347	1.7815	(23)
COMP	1.	MONOCULTURE	87.8437	5.2312	1.4883	2.2105	(11)
COMP	2.	MIXTURE	48.0028	4.0838	0.9307	0.8663	(12)
SPAC	2.	3 CM SPACING	158.8188	4.8852	2.1059	4.4380	(34)
COMP	1.	MONOCULTURE	70.8353	5.4489	3.0529	9.3204	(13)
COMP	2.	MIXTURE	87.7815	4.1801	1.0420	1.0858	(21)
SPAC	3.	9 CM SPACING	180.3801	4.2860	2.1012	4.4152	(36)
COMP	1.	MONOCULTURE	88.8478	6.1221	2.7883	7.7747	(13)
COMP	2.	MIXTURE	83.7722	3.8078	1.4280	2.0335	(22)
SPAC	4.	44 PLANTS M	108.2077	3.8846	3.1384	9.8493	(28)
COMP	1.	MONOCULTURE	42.8187	3.2782	0.3858	0.1284	(13)
COMP	2.	MIXTURE	88.5911	4.3727	4.2788	18.2808	(15)
SPAC	5.	28 PLANTS M	88.9322	2.9458	0.3807	0.1527	(20)
COMP	1.	MONOCULTURE	48.8528	3.0838	0.3804	0.1447	(15)
COMP	2.	MIXTURE	12.8788	2.8759	0.1182	0.0138	(5)
SPAC	6.	17 PLANTS M	88.8078	2.7804	0.4850	0.2070	(20)
COMP	1.	MONOCULTURE	38.8250	2.8404	0.4082	0.1686	(13)
COMP	2.	MIXTURE	18.8828	2.8890	0.8479	0.3001	(7)
SPAC	7.	10 PLANTS M	47.8447	2.5024	1.0789	1.1640	(18)
COMP	1.	MONOCULTURE	24.8728	3.0718	1.4283	2.0430	(8)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	22.9718	2.0883	0.4881	0.2173	(11)
CUL	3.	PARK	2459.8824	11.8412	82.5800	8718.0083	(208)
SPAC	1.	204 PLANTS M	188.4007	7.8580	8.1831	37.8802	(35)
COMP	1.	MONOCULTURE	55.9552	9.3280	8.9871	80.7889	(8)
COMP	2.	MIXTURE	140.4444	7.3518	8.2084	27.0888	(18)
SPAC	2.	3 CM SPACING	1704.3878	41.5704	320.8588	48848.0888	(41)
COMP	1.	MONOCULTURE	1479.7354	105.8884	377.9888	142880.8128	(14)
COMP	2.	MIXTURE	224.8524	8.3208	8.1181	37.3841	(27)
SPAC	3.	9 CM SPACING	151.8844	4.7381	1.3130	1.7241	(32)
COMP	1.	MONOCULTURE	51.8888	4.3218	0.8112	0.8882	(12)
COMP	2.	MIXTURE	99.8888	4.8848	1.8027	2.2582	(20)
SPAC	4.	44 PLANTS M	108.2888	3.8888	0.8888	0.3244	(27)
COMP	1.	MONOCULTURE	44.8788	4.0881	0.8818	0.4244	(11)
COMP	2.	MIXTURE	80.3100	3.7884	0.4847	0.2348	(18)
SPAC	5.	28 PLANTS M	104.8810	3.8188	1.1278	1.2721	(28)
COMP	1.	MONOCULTURE	59.4884	3.8887	1.4882	2.0388	(18)
COMP	2.	MIXTURE	45.3888	3.2428	0.8081	0.2882	(14)
SPAC	6.	17 PLANTS M	84.3217	3.8278	0.8387	0.7000	(28)
COMP	1.	MONOCULTURE	43.8778	3.3782	0.8377	0.4087	(13)
COMP	2.	MIXTURE	80.4440	3.8803	0.8888	0.9138	(13)
SPAC	7.	10 PLANTS M	103.0472	3.8834	1.3888	1.8482	(28)
COMP	1.	MONOCULTURE	57.1218	4.3848	1.7828	3.1774	(13)
COMP	2.	MIXTURE	45.9154	3.8320	0.8214	0.2718	(13)
CUL	4.	70M008002	880.1438	8.3800	8.4881	42.0881	(128)
SPAC	1.	204 PLANTS M	210.7883	10.8400	13.8878	187.3483	(20)
COMP	2.	MIXTURE	210.7883	10.8400	13.8878	187.3483	(20)
SPAC	2.	3 CM SPACING	148.3887	8.8084	8.8488	38.3488	(22)
COMP	2.	MIXTURE	148.3887	8.8084	8.8488	38.3488	(22)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	88.8487	4.3328	1.2834	1.8470	(20)
COMP	2.	MIXTURE	88.8487	4.3328	1.2834	1.8470	(20)
SPAC	4.	44 PLANTS M	78.2048	4.4828	3.2888	10.8208	(17)
COMP	2.	MIXTURE	78.2048	4.4828	3.2888	10.8208	(17)
SPAC	5.	28 PLANTS M	83.4871	3.3420	0.8708	0.3284	(18)
COMP	2.	MIXTURE	83.4871	3.3420	0.8708	0.3284	(18)
SPAC	6.	17 PLANTS M	88.7448	3.2872	1.0308	1.0828	(20)
COMP	2.	MIXTURE	88.7448	3.2872	1.0308	1.0828	(20)
SPAC	7.	10 PLANTS M	41.8828	3.8087	2.3818	8.5778	(11)
COMP	2.	MIXTURE	41.8828	3.8087	2.3818	8.5778	(11)
CUL	8.	NOROUAY	1208.8484	8.3141	38.7418	1508.9388	(148)
SPAC	1.	204 PLANTS M	282.2487	8.3500	11.4493	131.0884	(38)
COMP	1.	MONOCULTURE	74.0887	4.8284	1.4821	2.1088	(18)
COMP	2.	MIXTURE	218.1800	11.4832	14.8383	223.1834	(19)
SPAC	2.	3 CM SPACING	884.8883	28.4223	100.4278	10088.7418	(21)
COMP	1.	MONOCULTURE	38.7108	3.8878	1.0881	1.1218	(8)
COMP	2.	MIXTURE	819.1878	43.2831	132.7214	17814.8708	(12)
SPAC	3.	9 CM SPACING	100.0288	4.3881	1.8278	2.3340	(23)
COMP	1.	MONOCULTURE	38.3408	3.8341	0.8333	0.8710	(10)
COMP	2.	MIXTURE	80.8878	4.8883	1.8383	3.3718	(13)
SPAC	4.	44 PLANTS M	111.3881	4.1248	3.3122	10.8708	(27)
COMP	1.	MONOCULTURE	41.8104	3.7828	3.0888	9.4238	(11)
COMP	2.	MIXTURE	89.7887	4.3888	3.5480	12.8888	(18)
SPAC	5.	28 PLANTS M	41.8124	3.4827	2.0334	4.1348	(12)
COMP	1.	MONOCULTURE	41.8124	3.4827	2.0334	4.1348	(12)

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CRITERION VARIABLE H1

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	8.	17 PLANTS M	83.6378	8.6922	11.8935	138.7389	(8)
COMP	1.	MONOCULTURE	83.6378	8.6922	11.8935	138.7389	(8)
SPAC	7.	10 PLANTS M	81.8792	2.7147	0.8077	0.3883	(18)
COMP	1.	MONOCULTURE	28.0389	2.7818	0.7818	0.8800	(8)
COMP	2.	MIXTURE	28.5422	2.8842	0.4831	0.2144	(10)
CUL	8.	700000003	822.4852	8.4783	14.0770	188.1818	(127)
SPAC	1.	204 PLANTS M	159.4744	8.8897	12.8385	187.1837	(18)
COMP	2.	MIXTURE	159.4744	8.8897	12.8385	187.1837	(18)
SPAC	2.	3 CM SPACING	334.8328	18.8348	30.8583	952.2333	(21)
COMP	2.	MIXTURE	334.8328	18.8348	30.8583	952.2333	(21)
SPAC	3.	8 CM SPACING	78.1598	4.8850	1.7780	3.1814	(18)
COMP	2.	MIXTURE	78.1598	4.8850	1.7780	3.1814	(18)
SPAC	4.	44 PLANTS M	41.3023	3.4418	0.7280	0.8271	(12)
COMP	2.	MIXTURE	41.3023	3.4418	0.7280	0.8271	(12)
SPAC	8.	28 PLANTS M	88.8322	3.8982	1.4847	2.1488	(18)
COMP	2.	MIXTURE	88.8322	3.8982	1.4847	2.1488	(18)
SPAC	8.	17 PLANTS M	80.7894	4.1288	4.8888	21.8834	(22)
COMP	2.	MIXTURE	80.7894	4.1288	4.8888	21.8834	(22)
SPAC	7.	10 PLANTS M	81.8049	2.8802	0.4827	0.2330	(20)
COMP	2.	MIXTURE	81.8049	2.8802	0.4827	0.2330	(20)
CUL	7.	NDROUAY	248.7063	3.7888	1.8413	3.3804	(65)
SPAC	1.	204 PLANTS M	41.1018	8.1377	0.8211	0.8742	(8)
COMP	2.	MIXTURE	41.1018	8.1377	0.8211	0.8742	(8)
SPAC	2.	3 CM SPACING	67.4885	4.3142	1.8513	3.7267	(11)
COMP	1.	MONOCULTURE	24.8875	4.1148	2.2202	4.8898	(8)

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CRITERION VARIABLE H1

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	22.7890	4.5538	0.7238	0.5238	(5)
SPAC	3.	8 CM SPACING	23.2224	3.8704	2.3778	8.8542	(8)
COMP	1.	MONOCULTURE	23.2224	3.8704	2.3778	8.8542	(8)
SPAC	4.	44 PLANTS M	20.7438	3.4572	1.0708	1.1488	(8)
COMP	1.	MONOCULTURE	20.7438	3.4572	1.0708	1.1488	(8)
SPAC	5.	28 PLANTS M	20.1940	2.8848	0.3229	0.1043	(7)
COMP	2.	MIXTURE	20.1940	2.8848	0.3229	0.1043	(7)
SPAC	8.	17 PLANTS M	49.8140	3.3078	0.7008	0.4908	(15)
COMP	2.	MIXTURE	49.8140	3.3078	0.7008	0.4908	(15)
SPAC	7.	10 PLANTS M	44.3782	3.8980	3.2481	10.5378	(12)
COMP	1.	MONOCULTURE	14.8819	2.4770	0.4422	0.1857	(8)
COMP	2.	MIXTURE	29.5143	4.9191	4.4055	19.4088	(8)
CUL	8.	NR701	978.7090	8.4428	22.7857	518.8441	(180)
SPAC	1.	204 PLANTS M	110.3890	4.4148	0.8388	0.8810	(25)
COMP	2.	MIXTURE	110.3890	4.4148	0.8388	0.8810	(25)
SPAC	2.	3 CM SPACING	448.8609	14.4784	54.8447	2988.0378	(31)
COMP	2.	MIXTURE	448.8609	14.4784	54.8447	2988.0378	(31)
SPAC	3.	8 CM SPACING	84.0102	3.9171	1.3228	1.7481	(24)
COMP	2.	MIXTURE	84.0102	3.9171	1.3228	1.7481	(24)
SPAC	4.	44 PLANTS M	117.9122	3.9304	2.8098	7.8851	(30)
COMP	2.	MIXTURE	117.9122	3.9304	2.8098	7.8851	(30)
SPAC	8.	28 PLANTS M	81.4084	2.8559	0.4271	0.1824	(18)
COMP	2.	MIXTURE	81.4084	2.8559	0.4271	0.1824	(18)
SPAC	8.	17 PLANTS M	70.8120	3.0701	1.0811	1.1048	(23)
COMP	2.	MIXTURE	70.8120	3.0701	1.0811	1.1048	(23)
SPAC	7.	10 PLANTS M	88.8383	2.8841	0.8917	0.3801	(28)
COMP	2.	MIXTURE	88.8383	2.8841	0.8917	0.3801	(28)

TOTAL CASES = 1080
MISSING CASES = 48 OR 4.5 PCT.

Appendix 7. Descriptive statistics of characters of plants, grown in monoculture and in mixture at two interplant spacings, measured at maturity in 1978.

APPENDIX 7

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PAGE 2

FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	T	TILLERS PER PLANT					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
BY	MTR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3417.0000	6.0083	3.1273	9.7769	(669)
CUL	1.	PITIC 82	570.0000	8.9512	4.3800	19.0098	(82)
SPAC	2.	3 CM SPACING	217.0000	4.5208	1.3989	1.9570	(48)
MTR	2.	MIXTURE	217.0000	4.5208	1.3989	1.9570	(48)
SPAC	3.	9 CM SPACING	353.0000	10.3824	4.8117	23.1524	(34)
MTR	2.	MIXTURE	353.0000	10.3824	4.8117	23.1524	(34)
CUL	2.	GLENLEA	958.0000	8.6363	3.0840	9.5112	(170)
SPAC	2.	3 CM SPACING	309.0000	3.6788	1.1633	1.3533	(84)
MTR	1.	MONOCULTURE	82.0000	3.4444	0.9218	0.8497	(18)
MTR	2.	MIXTURE	247.0000	3.7424	1.2182	1.4838	(56)
SPAC	3.	9 CM SPACING	849.0000	7.6485	3.1788	10.1098	(88)
MTR	1.	MONOCULTURE	113.0000	6.2778	2.4448	5.9771	(18)
MTR	2.	MIXTURE	536.0000	7.8824	3.2808	10.7621	(58)
CUL	3.	PARK	758.0000	8.9585	2.3899	5.6974	(127)
SPAC	2.	3 CM SPACING	304.0000	4.6788	1.3931	1.9409	(85)
MTR	1.	MONOCULTURE	89.0000	5.3838	0.8090	0.6545	(11)
MTR	2.	MIXTURE	245.0000	4.6370	1.4800	2.1924	(54)
SPAC	3.	9 CM SPACING	464.0000	7.3228	2.4680	6.0910	(82)
MTR	1.	MONOCULTURE	113.0000	8.4167	2.2344	4.9924	(12)
MTR	2.	MIXTURE	341.0000	8.8200	2.2850	5.1302	(50)
CUL	4.	70M009002	550.0000	5.8511	2.6959	7.2679	(94)
SPAC	2.	3 CM SPACING	189.0000	4.1087	1.1201	1.2546	(46)
MTR	1.	MONOCULTURE	77.0000	4.2778	1.0741	1.1536	(18)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	112.0000	4.0000	1.1847	1.3333	(88)
SPAC	3.	9 CM SPACING	381.0000	7.8308	2.7132	7.3813	(48)
MTR	1.	MONOCULTURE	144.0000	8.0000	2.8808	8.7088	(18)
MTR	2.	MIXTURE	217.0000	7.2333	2.8888	8.3555	(30)
CUL	5.	NORQUAY	581.0000	8.0821	3.1030	9.6288	(96)
SPAC	2.	3 CM SPACING	143.0000	3.8722	1.8818	2.8578	(36)
MTR	1.	MONOCULTURE	70.0000	3.8889	1.2783	1.6340	(18)
MTR	2.	MIXTURE	73.0000	4.0888	2.0428	4.1732	(18)
SPAC	3.	9 CM SPACING	438.0000	7.3000	3.0888	9.5034	(80)
MTR	1.	MONOCULTURE	138.0000	7.8887	3.1808	10.1178	(18)
MTR	2.	MIXTURE	300.0000	7.1428	3.0887	9.5401	(42)
TOTAL CASES =			570				
MISSING CASES =			1 OR 0.2 PCT.				

APPENDIX 7

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FILE SPHERC (CREATION DATE = 12/30/81)

CRITERION VARIABLE H
BROKEN DOWN BY CUL
BY SPAC
BY MTR
DESCRIPTION OF SUBPOPULATIONS
HEADS PER PLANT
CULTIVAR
INTER-PLANT SPACING
TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3043.0000	5.3480	2.8381	8.0597	(569)
CUL	1.	PITIC 82	484.0000	5.8585	3.1040	9.6350	(82)
SPAC	2.	3 CM SPACING	187.0000	3.8888	1.4178	2.0102	(48)
MTR	2.	MIXTURE	187.0000	3.8888	1.4178	2.0102	(48)
SPAC	3.	9 CM SPACING	277.0000	8.1471	3.1443	9.8888	(34)
MTR	2.	MIXTURE	277.0000	8.1471	3.1443	9.8888	(34)
CUL	2.	GLENLEA	808.0000	4.7412	2.4430	5.9681	(170)
SPAC	2.	3 CM SPACING	272.0000	3.2381	1.0014	1.0029	(84)
MTR	1.	MONOCULTURE	88.0000	3.0556	1.0556	1.1144	(18)
MTR	2.	MIXTURE	217.0000	3.2879	0.8888	0.8774	(88)
SPAC	3.	9 CM SPACING	834.0000	8.2093	2.8443	8.0733	(88)
MTR	1.	MONOCULTURE	88.0000	4.7778	1.7878	3.1242	(18)
MTR	2.	MIXTURE	448.0000	8.8882	2.8930	8.7234	(88)
CUL	3.	PARK	708.0000	5.8827	2.1983	4.8324	(127)
SPAC	2.	3 CM SPACING	281.0000	4.4789	1.3123	1.7221	(88)
MTR	1.	MONOCULTURE	88.0000	5.2727	0.8048	0.6478	(11)
MTR	2.	MIXTURE	233.0000	4.3148	1.3293	1.7689	(84)
SPAC	3.	9 CM SPACING	418.0000	8.7419	2.3485	5.5081	(82)
MTR	1.	MONOCULTURE	88.0000	8.2600	2.3404	5.4773	(12)
MTR	2.	MIXTURE	318.0000	8.3800	2.2213	4.9343	(50)
CUL	4.	700008002	830.0000	5.8383	2.8798	7.1798	(84)
SPAC	2.	3 CM SPACING	183.0000	3.8783	1.1830	1.3988	(48)
MTR	1.	MONOCULTURE	74.0000	4.1111	1.1318	1.2810	(18)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	109.0000	3.8829	1.2274	1.5088	(22)
SPAC	3.	9 CM SPACING	347.0000	7.2282	2.7540	7.5947	(48)
MTR	1.	MONOCULTURE	132.0000	7.3889	3.0708	9.4381	(18)
MTR	2.	MIXTURE	214.0000	7.1333	2.8862	8.3402	(30)
CUL	3.	MONOCULTURE	534.0000	8.8828	2.8878	8.3381	(88)
SPAC	2.	3 CM SPACING	133.0000	3.8844	1.2280	1.5128	(22)
MTR	1.	MONOCULTURE	70.0000	3.8889	1.2783	1.6340	(18)
MTR	2.	MIXTURE	93.0000	3.8000	1.3088	1.7132	(18)
SPAC	3.	9 CM SPACING	401.0000	8.8833	3.0337	9.2031	(80)
MTR	1.	MONOCULTURE	124.0000	8.8889	3.1038	9.6340	(18)
MTR	2.	MIXTURE	277.0000	8.8862	3.0388	9.2334	(42)
TOTAL CASES = 570							
MISSING CASES = 1 OR 0.2 PCT.							

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	WT	DRY WEIGHT PER PLANT G					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
BY	MTR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			11137.8852	19.7127	12.0896	145.8781	(585)
CUL	1.	PITIC 82	1775.1194	21.8478	14.8053	210.4028	(82)
SPAC	2.	3 CM SPACING	635.3287	13.2380	4.8013	24.0230	(48)
MTR	2.	MIXTURE	635.3287	13.2380	4.8013	24.0230	(48)
SPAC	3.	9 CM SPACING	1139.7897	33.5232	15.2873	234.0089	(34)
MTR	2.	MIXTURE	1139.7897	33.5232	15.2873	234.0089	(34)
CUL	3.	GLENLEA	3887.8485	22.8623	13.7537	189.1842	(188)
SPAC	2.	3 CM SPACING	1147.4994	13.8283	4.8787	21.8899	(83)
MTR	1.	MONOCULTURE	207.3389	12.1888	4.8708	21.8148	(17)
MTR	2.	MIXTURE	940.1595	14.2448	4.8230	21.3728	(88)
SPAC	3.	9 CM SPACING	2710.1491	31.8841	13.8448	191.8705	(86)
MTR	1.	MONOCULTURE	478.2788	28.4800	10.1277	102.7738	(18)
MTR	2.	MIXTURE	2233.8694	33.3413	14.3977	207.2928	(87)
CUL	3.	PARK	1814.8990	14.2880	8.9702	80.5831	(127)
SPAC	2.	3 CM SPACING	870.3188	10.3128	3.7983	14.4042	(88)
MTR	1.	MONOCULTURE	181.4389	8.3443	3.8188	14.5843	(12)
MTR	2.	MIXTURE	688.8797	8.7802	3.8874	14.8793	(53)
SPAC	3.	9 CM SPACING	1144.3794	18.4877	7.1223	50.7277	(82)
MTR	1.	MONOCULTURE	308.8199	25.8017	7.2732	52.8898	(12)
MTR	2.	MIXTURE	834.7595	18.8882	8.8074	77.4873	(80)
CUL	4.	700009002	1828.4892	19.8529	10.7884	115.3472	(82)
SPAC	2.	3 CM SPACING	845.8898	12.4089	3.8878	13.8739	(44)
MTR	1.	MONOCULTURE	230.1089	14.3819	3.7247	13.8731	(18)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	315.8798	11.2814	3.2318	10.4448	(28)
SPAC	3.	8 CM SPACING	1290.4798	29.8787	10.8485	113.3288	(48)
MTR	1.	MONOCULTURE	828.2398	29.3487	13.3521	182.8742	(18)
MTR	2.	MIXTURE	752.2387	28.0747	9.3383	87.1477	(30)
CUL	5.	NORQUAY	1883.7592	19.4142	10.7583	115.9884	(98)
SPAC	2.	3 CM SPACING	427.7998	11.8833	5.0817	25.8232	(36)
MTR	1.	MONOCULTURE	248.0398	13.6133	4.8871	20.8887	(18)
MTR	2.	MIXTURE	182.7598	10.1533	5.0880	25.8889	(18)
SPAC	3.	8 CM SPACING	1438.8894	23.9327	10.7521	115.8075	(80)
MTR	1.	MONOCULTURE	482.8898	28.1894	11.1242	123.7483	(18)
MTR	2.	MIXTURE	883.0898	23.4089	10.8821	114.1675	(42)
TOTAL CASES =			570				
MISSING CASES =			5 OR 0.8 PCT.				

APPENDIX 7

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FILE SPHERC (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	Y	SEED YIELD PER PLANT &					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
BY	MTR	TREATMENT					

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			4901.1880	8.5888	5.4054	29.2182	(570)
CUL	1.	PITIC 82	777.8887	9.4828	5.3216	28.9621	(82)
SPAC	2.	3 CM SPACING	279.8888	5.8333	2.4868	6.2342	(48)
MTR	2.	MIXTURE	279.8888	5.8333	2.4868	6.2342	(48)
SPAC	3.	8 CM SPACING	487.8888	14.6353	5.5180	42.4847	(34)
MTR	2.	MIXTURE	487.8888	14.6353	5.5180	42.4847	(34)
CUL	2.	GLENEA	1878.1882	9.8800	5.9197	35.0428	(170)
SPAC	2.	3 CM SPACING	504.8888	5.0071	2.0848	4.3452	(84)
MTR	1.	MONOCULTURE	84.8000	5.2722	2.2887	5.0880	(18)
MTR	2.	MIXTURE	409.8888	5.2075	2.0069	4.0276	(85)
SPAC	3.	8 CM SPACING	1171.8884	13.6232	5.0359	25.4318	(88)
MTR	1.	MONOCULTURE	194.8888	10.8187	4.2017	18.5050	(18)
MTR	2.	MIXTURE	976.8888	14.3882	5.2324	27.8479	(88)
CUL	3.	PARK	747.8887	5.8414	3.0273	9.1843	(128)
SPAC	2.	3 CM SPACING	271.8888	4.1187	1.8287	2.9482	(88)
MTR	1.	MONOCULTURE	80.2000	5.0187	1.2948	1.6761	(12)
MTR	2.	MIXTURE	211.8888	3.8204	1.6355	2.6749	(54)
SPAC	3.	8 CM SPACING	475.8888	7.8742	3.1048	9.8387	(62)
MTR	1.	MONOCULTURE	127.3000	10.8083	3.8943	10.8554	(12)
MTR	2.	MIXTURE	348.4888	5.8700	2.6444	6.9928	(50)
CUL	4.	70MOOR002	880.8887	9.1585	5.1524	26.5471	(94)
SPAC	2.	3 CM SPACING	280.8888	5.8874	1.7823	3.2125	(48)
MTR	1.	MONOCULTURE	117.8000	5.8444	1.8971	3.5991	(18)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	142.8999	8.1038	1.4885	2.2455	(28)
SPAC	3.	8 CM SPACING	800.1999	12.8042	5.1082	26.0826	(48)
MTR	1.	MONOCULTURE	241.7999	13.4333	5.7384	32.9088	(18)
MTR	2.	MIXTURE	358.3999	11.8487	4.7058	22.1425	(30)
CUL	5.	NORQUAY	838.7997	8.7375	5.1240	26.2552	(98)
SPAC	2.	3 CM SPACING	187.3999	5.2088	2.2877	5.2337	(38)
MTR	1.	MONOCULTURE	108.8000	8.0500	2.0523	4.2121	(18)
MTR	2.	MIXTURE	78.8000	4.3811	2.2478	5.0531	(18)
SPAC	3.	8 CM SPACING	881.3998	10.8887	5.1884	26.9920	(80)
MTR	1.	MONOCULTURE	207.8998	11.8333	5.4488	29.6888	(18)
MTR	2.	MIXTURE	443.7999	10.8887	5.1231	26.2462	(42)
TOTAL CASES =			870				

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FILE SPHERC (CREATION DATE = 12/30/81)

CRITERION VARIABLE Y

BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS					
BY		BY					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			119998.0000	210.5228	128.6219	18033.1111	(570)
CUL	1.	PITIC 82	21420.0000	261.2185	173.2322	30009.3833	(82)
SPAC	2.	3 CM SPACING	7884.0000	183.8333	85.1088	4238.7376	(48)
MTR	2.	MIXTURE	7884.0000	183.8333	85.1088	4238.7376	(48)
SPAC	3.	8 CM SPACING	13556.0000	398.7059	185.3432	34352.0927	(34)
MTR	2.	MIXTURE	13556.0000	398.7059	185.3432	34352.0927	(34)
CUL	2.	GLENLEA	33728.0000	188.4000	112.2853	12803.8077	(170)
SPAC	2.	3 CM SPACING	10471.0000	124.8548	40.8725	1670.8861	(84)
MTR	1.	MONOCULTURE	2087.0000	114.2778	45.7487	2083.0369	(18)
MTR	2.	MIXTURE	8414.0000	127.4848	38.3424	1547.8228	(86)
SPAC	3.	8 CM SPACING	23287.0000	270.4302	113.1535	12803.7088	(86)
MTR	1.	MONOCULTURE	3902.0000	218.7778	85.6883	7325.3585	(18)
MTR	2.	MIXTURE	19385.0000	284.8324	115.7876	13408.7733	(88)
CUL	3.	PARK	21287.0000	188.1484	81.2985	5805.4802	(128)
SPAC	2.	3 CM SPACING	7881.0000	119.1081	44.2878	1961.3886	(66)
MTR	1.	MONOCULTURE	1878.0000	139.8333	36.9212	1280.3333	(12)
MTR	2.	MIXTURE	6183.0000	114.8000	44.9309	2018.7830	(84)
SPAC	3.	8 CM SPACING	13408.0000	218.2288	82.0209	8727.4238	(82)
MTR	1.	MONOCULTURE	3517.0000	293.0833	84.0881	7070.8108	(12)
MTR	2.	MIXTURE	8889.0000	197.7800	70.8888	4993.8078	(50)
CUL	4.	70MOO8002	22202.0000	236.2021	125.8310	15888.6148	(94)
SPAC	2.	3 CM SPACING	7133.0000	155.0882	44.1701	1950.9957	(48)
MTR	1.	MONOCULTURE	3131.0000	173.9444	44.1741	1951.3497	(18)

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CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	4002.0000	142.8288	40.4082	1632.8914	(28)
SPAC	3.	8 CM SPACING	15070.0000	312.9583	129.9771	16884.0408	(48)
MTR	1.	MONOCULTURE	8912.0000	328.4444	145.8198	21145.8497	(18)
MTR	2.	MIXTURE	8188.0000	308.2887	121.8531	14778.1878	(30)
CUL	8.	NDROUAY	21380.0000	222.7033	133.1328	17724.3772	(98)
SPAC	2.	3 CM SPACING	4738.0000	131.8278	85.3428	3082.8278	(38)
MTR	1.	MONOCULTURE	3720.0000	181.1111	80.7884	2890.8783	(18)
MTR	2.	MIXTURE	2015.0000	111.8444	53.8733	2813.1144	(18)
SPAC	3.	8 CM SPACING	18848.0000	277.4187	138.4027	18808.7048	(80)
MTR	1.	MONOCULTURE	8322.0000	288.8687	145.2877	21102.7088	(18)
MTR	2.	MIXTURE	11323.0000	289.8952	123.4738	17818.2712	(42)
TOTAL CASES =			870				

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FILE SPHERG (CREATION DATE = 12/30/81)

CRITERION VARIABLE KWT DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	KWT	DESCRIPTION	WEIGHT PER 1000 KERNELS C				
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
BY	MTR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			23118.3103	40.5584	8.8782	48.8982	(570)
CUL	1.	PITIC 82	2888.8823	36.4217	4.4188	19.8343	(82)
SPAC	2.	3 CM SPACING	1718.9851	35.8122	4.8272	24.2778	(48)
MTR	2.	MIXTURE	1718.9851	35.8122	4.8272	24.2778	(48)
SPAC	3.	8 CM SPACING	1287.5972	37.2823	3.4738	12.0871	(34)
MTR	2.	MIXTURE	1287.5972	37.2823	3.4738	12.0871	(34)
CUL	2.	GLEHLEA	8322.3251	48.9549	4.7343	22.4138	(170)
SPAC	2.	3 CM SPACING	4038.4008	48.0524	4.8280	24.2860	(84)
MTR	1.	MONOCULTURE	828.7813	48.8323	7.5025	56.2883	(18)
MTR	2.	MIXTURE	3209.8184	48.8308	3.8313	14.8789	(86)
SPAC	3.	8 CM SPACING	4285.8244	48.8383	4.3808	19.2780	(86)
MTR	1.	MONOCULTURE	892.8471	48.5888	3.4094	11.6239	(18)
MTR	2.	MIXTURE	3393.3773	48.9028	4.8385	21.4878	(88)
CUL	3.	PARK	4441.8273	34.7028	3.8233	12.4137	(128)
SPAC	2.	3 CM SPACING	2282.8280	34.2807	2.8128	7.9121	(88)
MTR	1.	MONOCULTURE	430.8100	35.8758	1.8824	2.8304	(12)
MTR	2.	MIXTURE	1832.0180	33.8283	2.9003	8.4120	(84)
SPAC	3.	8 CM SPACING	2178.3884	35.1518	4.1281	17.0185	(82)
MTR	1.	MONOCULTURE	432.1847	38.0128	1.1382	1.2888	(12)
MTR	2.	MIXTURE	1747.2447	34.9469	4.5482	20.8677	(80)
CUL	4.	70M008002	3587.3030	38.1828	3.8839	15.8711	(94)
SPAC	2.	3 CM SPACING	1871.2930	38.3325	3.8205	15.3700	(48)
MTR	1.	MONOCULTURE	872.7784	37.3788	3.2713	10.7018	(18)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2	MIXTURE	988.5138	38.8812	4.2053	17.8848	(28)
SPAC	3	9 CM SPACING	1818.0100	38.8188	3.2043	10.2874	(48)
MTR	1	MONOCULTURE	740.1388	41.1188	2.8103	8.8137	(18)
MTR	2	MIXTURE	1178.8714	38.1887	3.3483	11.2113	(30)
CUL	8	NORQUAY	3780.1728	38.3788	2.8828	8.7787	(98)
SPAC	3	3 CM SPACING	1818.0812	38.3073	2.8848	8.8814	(38)
MTR	1	MONOCULTURE	723.7080	40.2088	2.0188	4.0787	(18)
MTR	2	MIXTURE	891.3882	38.4088	2.8228	7.8870	(18)
SPAC	3	9 CM SPACING	2388.1113	38.4188	3.1881	10.1838	(80)
MTR	1	MONOCULTURE	710.8708	38.4817	1.8884	3.4808	(18)
MTR	2	MIXTURE	1884.4408	38.3814	3.8288	13.1788	(42)
TOTAL CASES =			870				

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FILE SPHERG (CREATION DATE = 12/30/81)

CRITERION VARIABLE DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE BROKEN DOWN BY		KH CUL BY BY BY	NUMBER OF KERNELS PER HEAD CULTIVAR INTER-PLANT SPACING TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N	
FOR ENTIRE POPULATION			22084.1702	38.8298	9.8444	98.8913	(588)	
CUL	1	PITIC 82	3721.0482	45.3788	12.2144	148.1827	(82)	
SPAC	2	3 CM SPACING	2088.7488	43.0873	13.2478	178.8083	(48)	
MTR	2	MIXTURE	2088.7488	43.0873	13.2478	178.8083	(48)	
SPAC	3	9 CM SPACING	1884.2893	48.8888	8.8887	97.3329	(34)	
MTR	2	MIXTURE	1884.2893	48.8888	8.8887	97.3329	(34)	
CUL	2	GLENLEA	7028.0818	41.3474	7.2883	52.8623	(170)	
SPAC	2	3 CM SPACING	3248.8888	38.8774	8.1383	37.8418	(84)	
MTR	1	MONOCULTURE	870.7488	37.2838	8.1714	38.0880	(18)	
MTR	2	MIXTURE	2878.1488	39.0828	8.1188	37.4007	(86)	
SPAC	3	9 CM SPACING	3780.1821	43.8853	7.3827	54.0828	(88)	
MTR	1	MONOCULTURE	818.7842	48.4888	8.1887	87.1883	(18)	
MTR	2	MIXTURE	2881.3878	43.8488	7.1237	80.7488	(88)	
CUL	3	PARK	3883.8888	28.0838	8.8483	44.1887	(127)	
SPAC	2	3 CM SPACING	1702.8184	28.1841	8.3883	28.8298	(88)	
MTR	1	MONOCULTURE	282.7878	28.7088	8.8788	31.0878	(11)	
MTR	2	MIXTURE	1418.8188	28.2828	8.3788	28.8888	(84)	
SPAC	3	9 CM SPACING	1881.0432	32.1138	8.8438	42.8223	(82)	
MTR	1	MONOCULTURE	431.7888	38.8808	8.8328	28.1883	(12)	
MTR	2	MIXTURE	1888.2588	31.1888	8.3827	40.8888	(88)	
CUL	4	TOMCO8002	3814.8547	41.8442	7.7843	80.1280	(84)	
SPAC	2	3 CM SPACING	1824.7332	38.8881	7.4411	88.3883	(48)	
MTR	1	MONOCULTURE	777.2888	43.1833	7.4782	88.9384	(18)	

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1047.4333	37.4083	8.8978	43.6281	(28)
SPAC	3.	9 CM SPACING	2089.8218	43.5379	7.8473	88.4811	(48)
MTR	1.	MONOCULTURE	802.3407	44.8748	7.3981	84.8878	(18)
MTR	2.	MIXTURE	1287.4809	42.8180	7.8820	81.8548	(30)
CUL	8.	NORQUAY	3735.8847	38.9182	8.3471	89.8734	(98)
SPAC	2.	3 CM SPACING	1278.8781	38.6243	8.1184	85.8808	(38)
MTR	1.	MONOCULTURE	708.7088	38.4283	7.1817	81.1487	(18)
MTR	2.	MIXTURE	888.1888	31.8204	7.2231	82.1734	(18)
SPAC	3.	9 CM SPACING	2488.8787	40.8488	7.8871	81.8818	(80)
MTR	1.	MONOCULTURE	784.7011	42.4834	8.8170	88.3484	(18)
MTR	2.	MIXTURE	1893.2778	40.2933	8.8418	48.8102	(42)
TOTAL CASES =			870				
MISSING CASES =			1 OR 0.2 PCT.				

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	HI	DESCRIPTION					
BROKEN DOWN BY	CUL	HARVEST INDEX					
BY	SPAC	CULTIVAR					
BY	MTR	INTER-PLANT SPACING					
		TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			245.2853	0.4341	0.0482	0.0023	(555)
CUL	1.	PITIC 82	38.0719	0.4388	0.0664	0.0044	(82)
SPAC	2.	3 CM SPACING	21.0045	0.4376	0.0733	0.0084	(48)
MTR	2.	MIXTURE	21.0045	0.4376	0.0733	0.0084	(48)
SPAC	3.	9 CM SPACING	18.0674	0.4432	0.0583	0.0032	(34)
MTR	2.	MIXTURE	18.0674	0.4432	0.0583	0.0032	(34)
CUL	2.	GLENLEA	73.1100	0.4352	0.0402	0.0018	(188)
SPAC	2.	3 CM SPACING	38.8848	0.4408	0.0412	0.0017	(83)
MTR	1.	MONOCULTURE	7.8878	0.4810	0.0890	0.0038	(17)
MTR	2.	MIXTURE	28.8188	0.4381	0.0383	0.0012	(88)
SPAC	3.	9 CM SPACING	38.8285	0.4287	0.0387	0.0018	(88)
MTR	1.	MONOCULTURE	7.3348	0.4078	0.0821	0.0027	(18)
MTR	2.	MIXTURE	28.1907	0.4387	0.0322	0.0010	(87)
CUL	3.	PARK	81.4721	0.4083	0.0431	0.0018	(127)
SPAC	2.	3 CM SPACING	28.8283	0.3948	0.0397	0.0018	(88)
MTR	1.	MONOCULTURE	4.7884	0.3872	0.0840	0.0041	(12)
MTR	2.	MIXTURE	21.1898	0.3892	0.0327	0.0011	(83)
SPAC	3.	9 CM SPACING	28.8487	0.4130	0.0457	0.0021	(82)
MTR	1.	MONOCULTURE	4.8881	0.4073	0.0278	0.0008	(12)
MTR	2.	MIXTURE	20.8877	0.4132	0.0482	0.0024	(80)
CUL	4.	70008002	42.2242	0.4580	0.0386	0.0013	(92)
SPAC	2.	3 CM SPACING	18.8848	0.4518	0.0380	0.0012	(44)
MTR	1.	MONOCULTURE	7.1808	0.4488	0.0444	0.0020	(16)

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CRITERION VARIABLE H1

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	12.8839	0.4830	0.0280	0.0008	(28)
SPAC	3.	8 CM SPACING	22.3884	0.4858	0.0352	0.0012	(48)
MTR	1.	MONOCULTURE	8.1407	0.4823	0.0318	0.0010	(18)
MTR	2.	MIXTURE	14.2187	0.4740	0.0351	0.0012	(30)
CUL	5.	MONOCULTURE	42.4071	0.4417	0.0418	0.0017	(88)
SPAC	2.	3 CM SPACING	15.7377	0.4372	0.0453	0.0021	(38)
MTR	1.	MONOCULTURE	8.0308	0.4452	0.0425	0.0018	(18)
MTR	2.	MIXTURE	7.7088	0.4282	0.0474	0.0022	(18)
SPAC	3.	8 CM SPACING	28.8894	0.4445	0.0383	0.0015	(80)
MTR	1.	MONOCULTURE	8.0537	0.4491	0.0387	0.0013	(18)
MTR	2.	MIXTURE	18.8857	0.4428	0.0407	0.0017	(42)
TOTAL CASES =			570				
MISSING CASES =			5 OR	0.9 PCT.			

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE
BROKEN DOWN BY
BY CUL
BY SPAC
BY MTR

HEIGHT OF THE FLAG LEAF BLADE CM
CULTIVAR
INTER-PLANT SPACING
TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			30120.0000	52.8421	10.2888	105.4021	(870)
CUL	1.	PITTC 82	4338.0000	52.9024	7.2872	53.2486	(82)
SPAC	2.	3 CM SPACING	2891.0000	52.8782	7.4419	55.3825	(48)
MTR	2.	MIXTURE	2891.0000	52.8782	7.4419	55.3825	(48)
SPAC	3.	8 CM SPACING	1747.0000	51.3824	8.9108	47.7885	(34)
MTR	2.	MIXTURE	1747.0000	51.3824	8.9108	47.7885	(34)
CUL	2.	GLENLEA	10551.0000	52.8528	7.7347	59.8255	(170)
SPAC	2.	3 CM SPACING	5489.0000	55.2482	8.8703	43.1845	(84)
MTR	1.	MONOCULTURE	1240.0000	55.8889	8.8878	44.4575	(18)
MTR	2.	MIXTURE	4249.0000	54.3788	8.2508	39.0897	(88)
SPAC	3.	8 CM SPACING	5152.0000	50.0233	7.9142	52.8347	(88)
MTR	1.	MONOCULTURE	1077.0000	59.8333	8.0888	55.8588	(18)
MTR	2.	MIXTURE	4085.0000	50.0738	7.9255	52.8154	(88)
CUL	3.	PARK	8715.0000	52.4588	8.2614	58.2510	(128)
SPAC	2.	3 CM SPACING	3857.0000	52.8938	7.9838	53.4193	(86)
MTR	1.	MONOCULTURE	551.0000	54.2500	10.1388	102.7800	(12)
MTR	2.	MIXTURE	2808.0000	53.8148	7.8112	58.4175	(84)
SPAC	3.	8 CM SPACING	3159.0000	50.9518	8.3885	59.8812	(82)
MTR	1.	MONOCULTURE	519.0000	51.6833	7.3541	54.0833	(12)
MTR	2.	MIXTURE	2540.0000	50.8000	8.8820	74.8571	(50)
CUL	4.	70M008002	4285.0000	45.8987	5.8775	34.6445	(84)
SPAC	2.	3 CM SPACING	2117.0000	46.0217	8.8583	44.3329	(46)
MTR	1.	MONOCULTURE	833.0000	45.2778	6.6152	42.4477	(18)

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CRITERION VARIABLE B

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1284.0000	45.8571	5.8822	47.0898	(28)
SPAC	3.	9 CM SPACING	2159.0000	45.1875	5.0957	25.5595	(48)
MTR	1.	MONOCULTURE	814.0000	45.2222	4.1948	17.5848	(15)
MTR	2.	MIXTURE	1355.0000	45.1887	5.5775	31.1082	(30)
CUL	5.	NOROUAY	4128.0000	43.0104	5.5975	32.3473	(88)
SPAC	2.	3 CM SPACING	1850.0000	43.0555	5.5594	43.0254	(38)
MTR	1.	MONOCULTURE	777.0000	43.1857	7.1149	50.5175	(18)
MTR	2.	MIXTURE	773.0000	42.8444	6.1554	37.8375	(18)
SPAC	3.	9 CM SPACING	2579.0000	42.8833	5.1835	26.8590	(50)
MTR	1.	MONOCULTURE	784.0000	43.5555	5.4454	41.5555	(15)
MTR	2.	MIXTURE	1795.0000	42.7221	4.5555	20.7434	(42)
TOTAL CASES =			570				

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	D	DESCRIPTION	PLANT HEIGHT CM				
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
BY	MTR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			47404.0000	83.1849	15.0110	159.2573	(570)
CUL	1.	PITIC 82	5472.0000	75.9268	5.9770	50.5673	(82)
SPAC	2.	3 CM SPACING	3759.0000	75.8375	5.3340	27.1237	(48)
MTR	2.	MIXTURE	3755.0000	75.9375	5.3340	27.1237	(48)
SPAC	3.	9 CM SPACING	2583.0000	75.9115	5.5880	32.7193	(34)
MTR	2.	MIXTURE	2583.0000	75.9115	5.5880	32.7193	(34)
CUL	2.	ELENLEA	18004.0000	84.1412	5.9113	35.4115	(170)
SPAC	2.	3 CM SPACING	7955.0000	85.0885	7.4742	55.8539	(84)
MTR	1.	MONOCULTURE	1891.0000	83.9444	7.7950	60.7514	(18)
MTR	2.	MIXTURE	9294.0000	85.3538	7.4155	55.0042	(55)
SPAC	3.	9 CM SPACING	8019.0000	83.2442	10.0543	101.0926	(55)
MTR	1.	MONOCULTURE	1580.0000	83.3333	10.5630	112.0000	(15)
MTR	2.	MIXTURE	6339.0000	83.2208	10.0295	100.5924	(55)
CUL	3.	PARK	11375.0000	85.8984	11.2641	126.8794	(128)
SPAC	2.	3 CM SPACING	5871.0000	85.5545	12.5151	155.8287	(55)
MTR	1.	MONOCULTURE	1055.0000	87.5167	20.2550	410.2552	(12)
MTR	2.	MIXTURE	4816.0000	85.1552	10.3285	106.6443	(54)
SPAC	3.	9 CM SPACING	5508.0000	85.8387	5.8517	37.2522	(52)
MTR	1.	MONOCULTURE	1115.0000	83.1887	7.9057	62.5152	(12)
MTR	2.	MIXTURE	4390.0000	87.6000	10.0571	101.3455	(50)
CUL	4.	70M008002	5535.0000	70.6957	6.9345	48.0825	(54)
SPAC	2.	3 CM SPACING	3217.0000	69.6348	8.2352	67.8445	(45)
MTR	1.	MONOCULTURE	1313.0000	72.9444	7.0955	50.4055	(15)

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CRITERION VARIABLE D

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1904.0000	88.0000	8.4847	71.4815	(28)
SPAC	3.	9 CM SPACING	3419.0000	71.2282	8.4187	29.3283	(48)
MTR	1.	MONOCULTURE	1301.0000	72.2774	8.3008	28.0848	(18)
MTR	2.	MIXTURE	2118.0000	70.8000	8.4747	28.9724	(30)
CUL	8.	NOROUAY	8913.0000	72.0104	8.4809	29.8209	(88)
SPAC	3.	3 CM SPACING	2894.0000	72.0888	8.9854	35.8284	(38)
MTR	1.	MONOCULTURE	1322.0000	73.4444	8.8488	31.8088	(18)
MTR	2.	MIXTURE	1272.0000	70.8887	8.1453	37.7847	(18)
SPAC	3.	9 CM SPACING	4318.0000	71.8833	8.1732	26.7824	(80)
MTR	1.	MONOCULTURE	1285.0000	71.8444	8.7804	45.7028	(18)
MTR	2.	MIXTURE	3024.0000	72.0000	4.4228	19.8610	(42)
TOTAL CASES =			870				

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	HL	DESCRIPTION	HEADLENGTH CM	CULTIVAR	INTER-PLANT SPACING	TREATMENT	
BROKEN DOWN BY	CUL						
BY	SPAC						
BY	MTR						
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			8081.0000	10.8684	2.0884	4.2783	(870)
CUL	1.	PITIC 82	1021.0000	12.4512	1.8180	2.6210	(82)
SPAC	2.	3 CM SPACING	884.0000	12.1887	1.8890	2.5248	(48)
MTR	3.	MIXTURE	584.0000	12.1887	1.8890	2.5248	(48)
SPAC	3.	9 CM SPACING	437.0000	12.8529	1.5980	2.5535	(34)
MTR	2.	MIXTURE	437.0000	12.8529	1.5980	2.5535	(34)
CUL	2.	GLENLEA	1899.0000	11.1708	1.4059	1.9768	(170)
SPAC	2.	3 CM SPACING	908.0000	10.8088	1.3032	1.6982	(84)
MTR	1.	MONOCULTURE	192.0000	10.8887	1.1378	1.2941	(18)
MTR	2.	MIXTURE	718.0000	10.8488	1.3801	1.8228	(88)
SPAC	3.	9 CM SPACING	991.0000	11.5233	1.4202	2.0171	(88)
MTR	1.	MONOCULTURE	210.0000	11.8887	1.8718	2.4708	(18)
MTR	2.	MIXTURE	781.0000	11.4883	1.3875	1.9252	(88)
CUL	3.	PARK	1018.0000	7.8287	1.2048	1.4517	(128)
SPAC	2.	3 CM SPACING	484.0000	7.4848	1.0708	1.1459	(88)
MTR	1.	MONOCULTURE	91.0000	7.8833	0.8149	0.2682	(12)
MTR	2.	MIXTURE	403.0000	7.4830	1.1809	1.3477	(84)
SPAC	3.	9 CM SPACING	621.0000	8.4032	1.1889	1.3583	(82)
MTR	1.	MONOCULTURE	110.0000	8.1887	0.7177	0.5152	(12)
MTR	2.	MIXTURE	411.0000	8.2200	1.1830	1.3986	(50)
CUL	4.	70M008002	1071.0000	11.3838	1.8212	2.8283	(84)
SPAC	2.	3 CM SPACING	828.0000	11.4348	1.7894	3.0987	(48)
MTR	1.	MONOCULTURE	218.0000	12.0000	1.7180	2.9412	(18)

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CRITERION VARIABLE HL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	310.0000	11.0714	1.7188	2.9577	(28)
SPAC	3.	8 CM SPACING	548.0000	11.3542	1.4948	2.2338	(48)
MTR	1.	MONOCULTURE	218.0000	12.1111	1.4807	2.1048	(18)
MTR	2.	MIXTURE	327.0000	10.8000	1.3481	1.8173	(30)
CUL	8.	NORWAY	1078.0000	11.1878	1.1303	1.2852	(88)
SPAC	2.	3 CM SPACING	334.0000	10.9444	1.0940	1.1968	(38)
MTR	1.	MONOCULTURE	207.0000	11.8000	0.7071	0.5000	(18)
MTR	2.	MIXTURE	187.0000	10.3889	1.1448	1.3108	(18)
SPAC	3.	9 CM SPACING	681.0000	11.3500	1.1173	1.2483	(80)
MTR	1.	MONOCULTURE	208.0000	11.3889	1.1850	1.4041	(18)
MTR	2.	MIXTURE	478.0000	11.3333	1.0889	1.2033	(42)
TOTAL CASES =			870				

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FILE SPHERC (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE	DESCRIPTION	UNIT
BROKEN DOWN BY	CUL	EXTRUSION LENGTH CM
BY	SPAC	CULTIVAR
BY	MTR	INTER-PLANT SPACING
		TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			23385.0000	40.8812	8.8298	48.0228	(870)
CUL	1.	PITIC 82	3155.0000	38.4758	7.1851	51.3388	(82)
SPAC	2.	3 CM SPACING	1782.0000	37.1250	8.1178	85.8888	(48)
MTR	2.	MIXTURE	1782.0000	37.1250	8.1178	85.8888	(48)
SPAC	3.	8 CM SPACING	1373.0000	40.3824	5.0753	25.7585	(34)
MTR	2.	MIXTURE	1373.0000	40.3824	5.0753	25.7585	(34)
CUL	2.	GLENLEA	7252.0000	42.8588	8.4783	41.8421	(170)
SPAC	3.	3 CM SPACING	3404.0000	40.5238	8.8289	44.0388	(84)
MTR	1.	MONOCULTURE	843.0000	38.7222	5.0504	25.5085	(18)
MTR	2.	MIXTURE	2781.0000	41.8333	8.4388	41.4333	(88)
SPAC	3.	8 CM SPACING	3848.0000	44.7442	5.8113	31.4887	(88)
MTR	1.	MONOCULTURE	813.0000	45.1667	9.3818	40.8529	(18)
MTR	2.	MIXTURE	3035.0000	44.8324	5.4332	29.5188	(88)
CUL	3.	PARK	8878.0000	44.3584	7.8083	57.8855	(128)
SPAC	2.	3 CM SPACING	2808.0000	42.8485	8.4274	71.0210	(88)
MTR	1.	MONOCULTURE	485.0000	41.2600	12.3371	182.2048	(12)
MTR	2.	MIXTURE	2313.0000	42.8333	7.4194	55.0472	(84)
SPAC	3.	8 CM SPACING	2870.0000	48.2903	8.1228	37.4881	(82)
MTR	1.	MONOCULTURE	808.0000	50.7500	5.0295	25.2955	(12)
MTR	2.	MIXTURE	2261.0000	45.2200	5.9719	34.9508	(80)
CUL	4.	TOMCO89002	3421.0000	38.3838	5.2532	27.8861	(94)
SPAC	2.	3 CM SPACING	1826.0000	38.3478	8.0119	38.1430	(46)
MTR	1.	MONOCULTURE	886.0000	38.8867	8.0391	38.4708	(18)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	930.0000	33.2143	8.0211	25.2118	(28)
SPAC	3.	8 CM SPACING	1795.0000	37.3858	4.2313	17.8038	(48)
MTR	1.	MONOCULTURE	705.0000	38.1887	4.2737	18.2547	(18)
MTR	2.	MIXTURE	1090.0000	38.3333	3.8981	15.1854	(30)
CUL	8.	NDROUAY	2859.0000	40.1878	4.1818	17.5708	(98)
SPAC	2.	3 CM SPACING	1438.0000	39.8444	4.8184	21.3111	(38)
MTR	1.	MONOCULTURE	752.0000	41.7778	4.2803	18.0884	(18)
MTR	2.	MIXTURE	888.0000	38.1111	4.3235	18.6928	(18)
SPAC	3.	8 CM SPACING	2421.0000	40.3800	3.9481	15.5873	(80)
MTR	1.	MONOCULTURE	718.0000	39.7778	4.2731	18.1242	(18)
MTR	2.	MIXTURE	1705.0000	40.6952	3.7810	14.2958	(42)
TOTAL CASES =			570				

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FILE SPHERG (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	YH	SEED YIELD PER HEAD					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	SPAC	INTER-PLANT SPACING					
MTR	TREATMENT						
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			907.9388	1.5928	0.5388	0.2901	(570)
CUL	1.	PITIC 82	134.9181	1.8483	0.4502	0.2027	(82)
SPAC	2.	3 CM SPACING	73.8814	1.5350	0.4930	0.2430	(48)
MTR	2.	MIXTURE	73.8814	1.5350	0.4930	0.2430	(48)
SPAC	3.	8 CM SPACING	81.2387	1.8011	0.3287	0.1087	(34)
MTR	2.	MIXTURE	81.2387	1.8011	0.3287	0.1087	(34)
CUL	2.	CLENLEA	346.1883	2.0384	0.4619	0.2134	(170)
SPAC	2.	3 CM SPACING	158.9286	1.8882	0.4120	0.1697	(84)
MTR	1.	MONOCULTURE	31.3333	1.7407	0.8045	0.3855	(18)
MTR	2.	MIXTURE	125.5933	1.9025	0.3387	0.1154	(68)
SPAC	3.	8 CM SPACING	188.2688	2.2008	0.4503	0.2032	(86)
MTR	1.	MONOCULTURE	40.7857	2.2859	0.4825	0.2328	(18)
MTR	2.	MIXTURE	148.4841	2.1838	0.4442	0.1973	(88)
CUL	3.	PARK	129.3770	1.0108	0.2882	0.0828	(128)
SPAC	2.	3 CM SPACING	88.8567	0.8887	0.2419	0.0588	(88)
MTR	1.	MONOCULTURE	10.1898	0.8800	0.3368	0.1148	(12)
MTR	2.	MIXTURE	48.4589	0.8973	0.2181	0.0478	(54)
SPAC	3.	8 CM SPACING	70.7214	1.1407	0.2851	0.0811	(62)
MTR	1.	MONOCULTURE	15.5598	1.2888	0.2218	0.0481	(12)
MTR	2.	MIXTURE	55.1618	1.1032	0.3000	0.0900	(60)
CUL	4.	70M008002	150.1081	1.5888	0.3805	0.1300	(94)
SPAC	2.	3 CM SPACING	86.7418	1.4508	0.3401	0.1168	(48)
MTR	1.	MONOCULTURE	28.1383	1.6188	0.3251	0.1057	(18)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	37.6033	1.3430	0.3087	0.0953	(28)
SPAC	3.	8 CM SPACING	83.3885	1.7368	0.3250	0.1058	(48)
MTR	1.	MONOCULTURE	32.9880	1.8318	0.3200	0.1024	(18)
MTR	2.	MIXTURE	80.3884	1.8788	0.3197	0.1022	(30)
CUL	5.	NOROUAY	147.3272	1.8348	0.3848	0.1289	(88)
SPAC	2.	3 CM SPACING	80.8418	1.4087	0.3857	0.1334	(38)
MTR	1.	MONOCULTURE	28.6902	1.5883	0.3107	0.0965	(18)
MTR	2.	MIXTURE	22.0517	1.2261	0.3301	0.1090	(18)
SPAC	2.	8 CM SPACING	98.6983	1.8118	0.3277	0.1074	(80)
MTR	1.	MONOCULTURE	30.1402	1.8748	0.3838	0.1548	(18)
MTR	2.	MIXTURE	88.6881	1.8848	0.2884	0.0878	(82)
TOTAL CASES =			570				

Appendix 8. Distribution parameters of characters of single plants, grown in monoculture and in mixture, at two interplant spacings.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character ¹	Spacing (cm)	Skewness ^{2,3}		Kurtosis ³	
		Monoculture	Mixture	Monoculture	Mixture
T	3	0.47	0.88**	1.21	1.66**
H	3	0.53	0.40*	1.02	0.60
Wt	3	0.72*	0.38*	1.44*	0.78*
Y	3	0.91**	0.43*	0.71	0.42
K/P	3	0.59	0.47*	0.97	0.40
Kwt	3	0.54	-0.88**	3.41**	2.18**
K/H	3	0.90**	-0.16	1.53	0.52
HI	3	-0.09	-0.64**	5.99**	1.51**
FL	3	-0.82**	-0.29	0.87	0.57
Ht	3	-1.15**	-0.86**	1.57*	1.29**
ExL	3	0.40	-0.54**	1.51*	-0.13
HL	3	0.33	-0.40	0.65	0.97
T	9	0.20	0.63**	-0.48	0.49
H	9	-0.09	0.72**	-0.75	0.93*
Wt	9	0.12	0.29	-0.13	0.03
Y	9	-0.15	0.32	-0.46	0.12
K/P	9	-0.03	0.47*	-0.51	0.31
Kwt	9	-0.16	-1.36**	-0.02	3.40**
K/H	9	-0.34	-0.09	1.86**	0.04
HI	9	-1.46**	-0.89**	3.10**	2.64**
FL	9	0.33	0.31	-0.23	-0.16
Ht	9	-0.93**	0.07	1.24*	-0.08
ExL	9	-0.53	-0.37	0.52	-0.12
HL	9	-0.28	-0.41	0.33	0.58

1. Character abbreviations defined in Table 1, HL = Head Length.

2. Values of skewness and kurtosis are averages of four genotypes and three replicates.

3. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

Appendix 9. Relative Yield Totals¹ for several characters of plants grown in mixtures at two interplant spacings in 1978.

Mixture	Character ²											
	Y		T		H		Ket		HI		Wc	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
Glenlea + Park	0.94	1.13	1.03	1.15	0.97	1.25*	1.00	0.97	0.97	1.03	0.96	1.08
Glenlea + 70M09002	0.98	1.01	1.02	1.08	1.04	1.11	0.99	0.99	1.00	1.04	0.97	0.98
Glenlea + Norquay	0.88	1.12	0.99	1.12	0.95	1.23*	0.99	0.98	0.97	1.05	1.14	1.08
Park + 70M09002	0.78*	0.86	0.91	0.83	0.88	0.88	0.96	1.00	0.99	1.03	0.79**	0.84
Park + Norquay	1.00	0.93	1.11	0.95	1.00	0.97	0.99	1.01	0.99	0.99	0.97	0.98
											1.02	0.95
											0.97	0.95
											0.97	0.85**
											0.94	0.91
											1.00	0.90
											0.92	0.92
											1.05	0.95

1. See Section 6.2.

* significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1.

Appendix. 10. Descriptive statistics of characters of plants, grown
in monoculture and in mixture, in machine seeded plots,
measured at the flowering stage, in 1978.

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PAGE 2

FILE FLAGMENG (CREATION DATE = 03/16/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		HEIGHT OF THE FLAG LEAF BLADE CM					
BY		CULTIVAR TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			72272.0000	55.1685	12.2985	151.2532	(1310)
CUL	1.	PITIC 52	18829.0000	51.9722	8.3992	70.5472	(324)
COMP	1.	MONOCULTURE	4098.0000	51.2280	7.3329	53.7716	(80)
COMP	2.	MIXTURE	12741.0000	52.2172	8.7205	76.0473	(244)
CUL	2.	GLEHLEA	18378.0000	57.8155	8.4885	72.0547	(271)
COMP	1.	MONOCULTURE	4114.0000	58.5887	7.5428	56.8938	(80)
COMP	2.	MIXTURE	14264.0000	57.6019	8.7436	76.4503	(211)
CUL	3.	PARK	16983.0000	55.3112	13.0529	170.6842	(288)
COMP	1.	MONOCULTURE	3232.0000	53.8867	8.4858	71.8768	(80)
COMP	2.	MIXTURE	13751.0000	56.7558	13.9729	195.2427	(228)
CUL	4.	70M009002	5995.0000	47.6000	7.7877	60.3388	(210)
COMP	1.	MONOCULTURE	2779.0000	47.9138	7.5578	56.6416	(58)
COMP	2.	MIXTURE	7217.0000	47.4803	7.8310	61.3241	(152)
CUL	5.	NOROUAY	10096.0000	48.1008	7.8818	62.1142	(219)
COMP	1.	MONOCULTURE	2885.0000	48.0000	7.0813	50.1521	(59)
COMP	2.	MIXTURE	7441.0000	48.6082	7.8929	62.3144	(160)
TOTAL CASES =			1310				

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PAGE 3

FILE FLAGMERE (CREATION DATE = 03/16/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		BY					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			92380.0000	73.7271	16.4646	271.0836	(1263)
CUL	1.	PITIC 82	20618.0000	84.2488	11.5887	134.2980	(324)
COMP	1.	MONOCULTURE	5142.0000	84.2780	10.9440	119.7715	(80)
COMP	2.	MIXTURE	15576.0000	84.2377	11.8141	139.8729	(244)
CUL	2.	GLENLEA	23130.0000	85.3805	11.8836	141.4581	(271)
COMP	1.	MONOCULTURE	4977.0000	82.8500	12.3037	148.8287	(80)
COMP	2.	MIXTURE	18153.0000	85.0332	11.7438	137.9178	(211)
CUL	3.	PARK	21832.0000	88.0323	15.2384	232.2085	(248)
COMP	1.	MONOCULTURE	5178.0000	88.3000	15.0807	228.8237	(80)
COMP	2.	MIXTURE	16654.0000	88.5851	15.2931	233.8904	(188)
CUL	4.	70M008002	13573.0000	84.8333	11.5375	133.1137	(210)
COMP	1.	MONOCULTURE	2709.0000	83.8482	10.1107	102.2353	(58)
COMP	2.	MIXTURE	9864.0000	84.8947	12.0584	145.4081	(152)
CUL	5.	NORQUAY	13028.0000	85.1480	10.8977	120.8487	(200)
COMP	1.	MONOCULTURE	3859.0000	85.4088	11.7724	138.8903	(58)
COMP	2.	MIXTURE	9170.0000	85.0355	10.8887	114.4830	(141)
TOTAL CASES = 1310							
MISSING CASES = 57 OR 4.4 PCT.							

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FILE FLAGMERE (CREATION DATE = 03/16/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		BY					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14068.0000	11.2824	2.7777	7.7158	(1252)
CUL	1.	PITIC 82	4158.0000	12.8333	1.8826	2.8048	(324)
COMP	1.	MONOCULTURE	1031.0000	12.8875	1.4495	2.1011	(80)
COMP	2.	MIXTURE	3127.0000	12.8186	1.8263	2.8445	(244)
CUL	2.	GLENLEA	3037.0000	11.2088	2.0785	4.3201	(271)
COMP	1.	MONOCULTURE	868.0000	11.1333	1.8548	3.4395	(80)
COMP	2.	MIXTURE	2169.0000	11.2275	2.1415	4.5881	(211)
CUL	3.	PARK	2028.0000	8.2510	2.8886	12.8836	(247)
COMP	1.	MONOCULTURE	481.0000	8.0187	1.1122	1.2370	(80)
COMP	2.	MIXTURE	1547.0000	8.3282	4.0740	16.5873	(187)
CUL	4.	70M008002	2528.0000	12.0428	1.8378	3.7541	(210)
COMP	1.	MONOCULTURE	702.0000	12.1034	1.8228	3.3224	(58)
COMP	2.	MIXTURE	1827.0000	12.0187	1.8849	3.9400	(152)
CUL	5.	NORQUAY	2328.0000	11.8300	1.8380	2.8785	(200)
COMP	1.	MONOCULTURE	704.0000	11.8322	1.8525	3.5615	(58)
COMP	2.	MIXTURE	1622.0000	11.8035	1.8053	2.2681	(141)
TOTAL CASES = 1310							
MISSING CASES = 58 OR 4.4 PCT.							

APPENDIX 10

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PAGE 5

FILE FLAGMERC (CREATION DATE = 03/18/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		BY		EXTRUSION LENGTH CM			
				CULTIVAR TREATMENT			
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			20108.0000	15.3813	21.7845	475.0001	(1309)
CUL COMP COMP	1.	PITIC 82	3877.0000	12.3127	8.1882	28.8174	(323)
	1.	MONOCULTURE	1044.0000	13.0500	8.3389	28.8025	(80)
	2.	MIXTURE	2833.0000	12.0700	8.1288	28.2719	(243)
CUL COMP COMP	2.	GLENLEA	4752.0000	17.5351	8.8512	97.2433	(271)
	1.	MONOCULTURE	893.0000	14.2833	7.8382	58.3421	(80)
	2.	MIXTURE	3859.0000	18.4313	10.2484	104.9893	(211)
CUL COMP COMP	3.	PARK	4889.0000	17.0245	40.8948	1847.9488	(288)
	1.	MONOCULTURE	1848.0000	22.4333	11.6309	135.8815	(80)
	2.	MIXTURE	2933.0000	12.9335	44.4118	1972.4088	(228)
CUL COMP COMP	4.	70M008002	3577.0000	17.0333	8.3248	40.0037	(210)
	1.	MONOCULTURE	830.0000	18.0345	8.2894	38.8830	(58)
	2.	MIXTURE	2647.0000	17.4148	8.3135	38.8802	(152)
CUL COMP COMP	5.	NORQUAY	2833.0000	13.3827	21.8140	487.1883	(218)
	1.	MONOCULTURE	1204.0000	20.4088	8.4704	41.8882	(88)
	2.	MIXTURE	1729.0000	10.8052	24.5002	800.2578	(180)
TOTAL CASES = 1310							
MISSING CASES = 1 OR 0.1 PCT.							

APPENDIX 10

03/18/82

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FILE FLAGMERC (CREATION DATE = 03/18/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		BY		FLAGLEAF BLADE AREA CM SQ.			
				CULTIVAR TREATMENT			
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			31318.5937	24.1088	8.0818	84.8915	(1288)
CUL COMP COMP	1.	PITIC 82	8735.8982	27.0452	8.7224	45.1812	(323)
	1.	MONOCULTURE	2170.8985	27.4772	8.1888	38.2952	(79)
	2.	MIXTURE	6564.8987	26.9053	8.8927	47.5095	(244)
CUL COMP COMP	2.	GLENLEA	7848.0988	27.8558	7.2898	53.2477	(270)
	1.	MONOCULTURE	1848.8997	27.4450	7.4841	55.7123	(80)
	2.	MIXTURE	5999.1991	28.1018	7.2637	52.7818	(210)
CUL COMP COMP	3.	PARK	4821.8990	17.7875	8.1315	88.1207	(277)
	1.	MONOCULTURE	1008.2988	18.7717	8.5488	42.8492	(80)
	2.	MIXTURE	3813.5992	16.0429	8.6107	72.4318	(217)
CUL COMP COMP	4.	70M008002	4840.1990	23.0882	8.8444	44.1478	(210)
	1.	MONOCULTURE	1348.8997	23.2588	7.2015	51.8921	(58)
	2.	MIXTURE	3291.1993	21.8828	8.3884	40.8111	(152)
CUL COMP COMP	5.	NORQUAY	8473.0988	24.8913	8.4453	41.6424	(218)
	1.	MONOCULTURE	1488.7987	28.1830	8.4011	29.1721	(58)
	2.	MIXTURE	3987.2992	24.9208	8.8042	48.2978	(180)
TOTAL CASES = 1310							
MISSING CASES = 11 OR 0.8 PCT.							

Appendix 11. Descriptive statistics of characters of plants, grown in monoculture and in mixture, in machine seeded plots, measured at the middough stage, in 1978.

APPENDIX 11

03/18/82

PAGE 2

FILE FLAGMERC (CREATION DATE = 03/18/82)

CRITERION VARIABLE BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS HEIGHT OF THE FLAG LEAF BLADE CM CULTIVAR TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			89030.0000	54.3972	11.8228	132.7712	(1289)
CUL	1.	PITIC 82	15059.0000	52.2882	8.4822	71.8480	(288)
COMP	1.	MONOCULTURE	3139.0000	52.3187	8.2783	68.0608	(80)
COMP	2.	MIXTURE	11920.0000	52.2607	8.2825	68.5993	(228)
CUL	2.	GLENLEA	20114.0000	55.8028	10.8592	111.4981	(302)
COMP	1.	MONOCULTURE	3845.0000	51.7787	12.3428	152.3472	(89)
COMP	2.	MIXTURE	16469.0000	57.7737	8.7828	95.1180	(243)
CUL	3.	PARK	14537.0000	55.0844	9.0814	82.4711	(284)
COMP	1.	MONOCULTURE	2049.0000	51.2250	8.0208	64.3327	(40)
COMP	2.	MIXTURE	12488.0000	55.7500	9.1048	82.8989	(224)
CUL	4.	70M008002	10888.0000	47.7847	7.1433	51.0282	(221)
COMP	1.	MONOCULTURE	2831.0000	47.1833	8.8387	78.1184	(80)
COMP	2.	MIXTURE	7725.0000	47.9814	7.3280	52.2434	(161)
CUL	5.	NOROUAY	8784.0000	45.1783	8.8831	78.8834	(184)
COMP	1.	MONOCULTURE	3845.0000	43.8783	7.7881	60.6884	(88)
COMP	2.	MIXTURE	8219.0000	45.7278	8.0997	65.2088	(136)
TOTAL CASES =			1289				

APPENDIX 11

03/18/82

PAGE 3

FILE FLAGMERC (CREATION DATE = 03/18/82)

CRITERION VARIABLE BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS PLANT HEIGHT CM CULTIVAR TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			108208.0000	85.2887	14.7785	218.3150	(1289)
CUL	1.	PITIC 82	23322.0000	80.9792	10.8058	116.7861	(288)
COMP	1.	MONOCULTURE	4872.0000	81.2000	11.2292	125.0949	(80)
COMP	2.	MIXTURE	18450.0000	80.9211	10.7183	114.8398	(228)
CUL	2.	GLENLEA	28889.0000	98.3078	13.0519	171.3985	(302)
COMP	1.	MONOCULTURE	5558.0000	94.2203	13.8148	193.6230	(89)
COMP	2.	MIXTURE	24130.0000	99.3004	12.7187	161.7152	(243)
CUL	3.	PARK	24248.0000	81.8523	12.7320	162.1035	(284)
COMP	1.	MONOCULTURE	3536.0000	88.4000	14.1383	199.8388	(40)
COMP	2.	MIXTURE	20713.0000	92.4888	12.3981	153.7120	(224)
CUL	4.	70M008002	18484.0000	74.8335	8.5288	72.7080	(221)
COMP	1.	MONOCULTURE	4483.0000	74.8833	8.4027	70.6088	(80)
COMP	2.	MIXTURE	12001.0000	74.8404	8.2089	67.3374	(161)
CUL	5.	NOROUAY	14452.0000	74.4848	8.5191	72.8140	(184)
COMP	1.	MONOCULTURE	4328.0000	74.8207	11.0582	122.2388	(88)
COMP	2.	MIXTURE	10124.0000	74.4412	8.8274	77.9224	(136)
TOTAL CASES =			1289				

APPENDIX 11

03/18/82

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FILE FLAGHERG (CREATION DATE = 03/18/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		HL	HEADLENGTH CM				
		CUL	CULTIVAR				
		BY	TREATMENT				
		COMP					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14309.0000	11.2755	2.8255	8.3751	(1259)
CUL	1.	PITIC 82	3525.0000	13.2847	2.2513	5.0655	(288)
COMP	1.	MONOCULTURE	802.0000	13.2857	1.5290	2.3379	(80)
COMP	2.	MIXTURE	3024.0000	13.2832	2.4080	5.7953	(228)
CUL	2.	GLEMLEA	3235.0000	11.0430	1.7005	2.8915	(302)
COMP	1.	MONOCULTURE	558.0000	8.8881	2.1812	4.7575	(59)
COMP	2.	MIXTURE	2747.0000	11.3045	1.4509	2.1052	(243)
CUL	3.	PARK	2147.0000	8.1325	1.0558	1.2025	(284)
COMP	1.	MONOCULTURE	307.0000	7.5750	1.1551	1.4045	(40)
COMP	2.	MIXTURE	1840.0000	8.2143	1.0524	1.1233	(224)
CUL	4.	70M009002	2748.0000	12.4344	1.9285	3.7155	(221)
COMP	1.	MONOCULTURE	777.0000	12.9500	1.9551	3.8505	(80)
COMP	2.	MIXTURE	1971.0000	12.2422	1.8734	3.5097	(151)
CUL	5.	NOROUAY	2253.0000	11.5134	1.8448	2.7047	(194)
COMP	1.	MONOCULTURE	555.0000	11.4855	1.5935	2.5545	(55)
COMP	2.	MIXTURE	1558.0000	11.5755	1.8234	2.5353	(139)
TOTAL CASES =			1259				

APPENDIX 11

03/18/82

PAGE 5

FILE FLAGHERG (CREATION DATE = 03/18/82)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		EL	EXTRUSION LENGTH CM				
		CUL	CULTIVAR				
		BY	TREATMENT				
		COMP					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			38175.0000	30.9203	7.5245	55.1398	(1257)
CUL	1.	PITIC 82	8252.0000	28.5810	5.5954	31.3084	(285)
COMP	1.	MONOCULTURE	1733.0000	28.8233	4.9200	24.2055	(80)
COMP	2.	MIXTURE	6530.0000	28.8404	5.7589	33.2798	(225)
CUL	2.	GLEMLEA	9575.0000	31.8105	7.5403	55.3740	(301)
COMP	1.	MONOCULTURE	1914.0000	32.4407	8.2321	67.7580	(59)
COMP	2.	MIXTURE	7651.0000	31.5570	7.4990	55.2346	(242)
CUL	3.	PARK	9712.0000	35.7575	8.5572	75.4451	(284)
COMP	1.	MONOCULTURE	1487.0000	37.1750	8.9511	80.6809	(40)
COMP	2.	MIXTURE	8225.0000	35.7185	8.5534	75.3924	(224)
CUL	4.	70M009002	5935.0000	28.8553	5.2804	27.8872	(221)
COMP	1.	MONOCULTURE	1652.0000	27.7000	5.4595	30.2475	(80)
COMP	2.	MIXTURE	4275.0000	28.5590	5.1503	26.5355	(151)
CUL	5.	NOROUAY	5588.0000	29.4715	5.3755	28.8953	(193)
COMP	1.	MONOCULTURE	1783.0000	30.7414	6.2283	38.7915	(55)
COMP	2.	MIXTURE	3805.0000	28.9259	4.5593	20.9049	(135)
TOTAL CASES =			1259				
MISSING CASES =			2 OR	0.2 PCT.			

APPENDIX 11

03/18/83

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FILE PLASMERS (CREATION DATE = 03/18/83)

CRITERION VARIABLE BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS AREA CUL COMP		PLACELAP BLADE AREA CM SQ. CULTIVAR TREATMENT			
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			34578.1930	27.4888	9.1083	82.9240	(1288)
CUL	1.	PITIC 82	8878.1983	30.2411	7.7847	60.2811	(287)
COMP	1.	MONOCULTURE	1788.3988	28.8733	8.6212	43.8400	(80)
COMP	2.	MIXTURE	8880.7987	30.3119	8.0518	64.8288	(227)
CUL	2.	GLENLEA	8911.8983	33.0397	9.8973	97.9588	(300)
COMP	1.	MONOCULTURE	1720.1987	28.1889	11.8818	138.7888	(88)
COMP	2.	MIXTURE	8191.8988	33.8908	9.1988	84.6118	(241)
CUL	3.	PARK	4988.7988	18.3977	5.9838	35.8848	(258)
COMP	1.	MONOCULTURE	881.3988	18.8380	5.4182	28.3872	(40)
COMP	2.	MIXTURE	4304.3980	19.8278	5.9202	35.0483	(218)
CUL	4.	TOMOOS002	5784.8987	28.0403	7.4881	55.0414	(221)
COMP	1.	MONOCULTURE	1721.2986	28.8883	7.0428	49.6017	(80)
COMP	2.	MIXTURE	4033.8981	28.0834	7.4288	55.1887	(181)
CUL	5.	NORQUAY	5288.3988	27.1484	8.2823	38.8830	(194)
COMP	1.	MONOCULTURE	1838.8987	28.2082	8.9118	47.7731	(88)
COMP	2.	MIXTURE	3630.4982	28.8948	8.9787	38.7484	(138)

TOTAL CASES = 1288
MISSING CASES = 11 OR 0.9 PCT.

Appendix 12. Variation in thousand kernel weights (g) among the seed classes used in 1979.

Genotype	Seed class		
	Small	Large	Unsorted ¹
Pitic 62	29.8	40.8	--- ²
Glenlea	32.0	45.6	44.5
Park	25.8	36.0	34.9
70M009002	25.6	46.2	45.9
Norquay	25.5	38.0	37.3

1 Only sorted small and large seeds were used in the seed size experiment.

2 No data available.

Appendix 13. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at the 3-5 leaf stage, in 1979.

APPENDIX 13

03/15/82

PAGE 2

FILE SDL1 (CREATION DATE = 12/30/81)

----- DESCRIPTION OF SUBPOPULATIONS -----
CRITERION VARIABLE HT1 PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			8802.5000	17.8475	3.7851	14.1009	482
CUL	0.		1780.5000	17.1202	3.0173	9.1043	104
TR	1.	LARGE SEED	749.0000	17.8333	3.1693	10.0447	42
TR	2.	SMALL SEED	828.0000	17.3811	2.7376	7.4944	38
TR	3.	MIXED SEED	408.5000	16.8348	2.7039	7.3112	26
CUL	1.	PITIC 82	1850.5000	17.8238	2.8538	8.1432	105
TR	1.	LARGE SEED	888.0000	18.1316	1.9406	3.7680	38
TR	2.	SMALL SEED	575.0000	18.8118	3.0932	9.5677	34
TR	3.	MIXED SEED	588.5000	17.7727	3.3729	11.3784	33
CUL	2.	GLENLEA	2128.0000	19.1712	3.1855	10.1477	111
TR	1.	LARGE SEED	748.0000	19.8316	3.8742	15.0092	38
TR	2.	SMALL SEED	748.5000	19.6447	3.0732	9.4447	38
TR	3.	MIXED SEED	631.5000	18.1571	2.1817	4.6731	35
CUL	3.	PARK	1879.5000	19.1788	4.4509	19.8108	98
TR	1.	LARGE SEED	815.0000	19.8364	4.8742	23.8480	33
TR	2.	SMALL SEED	805.0000	19.8223	5.4190	29.3698	31
TR	3.	MIXED SEED	859.5000	19.3824	3.1456	9.8848	34
CUL	4.	70M009002	884.0000	15.0825	4.0537	16.4325	64
TR	1.	LARGE SEED	351.0000	15.2809	3.9986	15.9870	23
TR	2.	SMALL SEED	225.0000	14.0625	3.7854	14.3292	18
TR	3.	MIXED SEED	308.0000	15.5200	4.3120	18.5933	25

TOTAL CASES = 482

APPENDIX 13

03/16/82

PAGE 3

FILE SDL1 (CREATION DATE = 12/30/81)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY	BY	L1 CUL	NUMBER OF LEAVES				
		TR	CULTIVAR TREATMENT				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1782.0000	3.6556	0.8745	0.4549	(482)
CUL	0.		397.0000	3.8173	0.4978	0.2479	(104)
TR	1.	LARGE SEED	188.0000	3.7143	0.8982	0.3554	(42)
TR	2.	SMALL SEED	140.0000	3.8888	0.3984	0.1587	(38)
TR	3.	MIXED SEED	101.0000	3.8848	0.4318	0.1862	(26)
CUL	1.	PITIC 82	384.0000	3.6571	0.8175	0.3813	(105)
TR	1.	LARGE SEED	140.0000	3.3158	0.4711	0.2219	(38)
TR	2.	SMALL SEED	128.0000	3.7847	0.8989	0.4884	(34)
TR	3.	MIXED SEED	130.0000	3.8394	0.4982	0.2482	(33)
CUL	2.	GLENLEA	401.0000	3.6125	0.8204	0.3649	(111)
TR	1.	LARGE SEED	140.0000	3.8842	0.8818	0.4381	(38)
TR	2.	SMALL SEED	128.0000	3.3884	0.8334	0.4011	(38)
TR	3.	MIXED SEED	133.0000	3.8000	0.4728	0.2238	(35)
CUL	3.	PARK	348.0000	3.8510	0.7818	0.3738	(98)
TR	1.	LARGE SEED	120.0000	3.8384	0.7424	0.5511	(32)
TR	2.	SMALL SEED	111.0000	3.8808	0.7850	0.7849	(31)
TR	3.	MIXED SEED	117.0000	3.4412	0.8802	0.4358	(34)
CUL	4.	TOMODS002	232.0000	3.6250	0.8987	0.8095	(84)
TR	1.	LARGE SEED	88.0000	3.8281	1.1140	1.2411	(23)
TR	2.	SMALL SEED	58.0000	3.6000	0.8325	0.4000	(15)
TR	3.	MIXED SEED	88.0000	3.6200	0.8228	0.6787	(25)
TOTAL CASES =			482				

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FILE SDL1 (CREATION DATE = 12/30/81)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY	BY	T1 CUL	TILLERS PER PLANT				
		TR	CULTIVAR TREATMENT				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			921.0000	1.9108	0.8949	0.8005	(482)
CUL	0.		223.0000	2.1442	0.8178	0.5583	(104)
TR	1.	LARGE SEED	100.0000	2.3810	0.8084	0.3269	(42)
TR	2.	SMALL SEED	70.0000	1.8444	0.7808	0.5284	(38)
TR	3.	MIXED SEED	53.0000	2.0385	0.5867	0.3555	(26)
CUL	1.	PITIC 82	223.0000	2.1238	0.8955	0.8018	(105)
TR	1.	LARGE SEED	86.0000	2.2632	0.7947	0.5318	(38)
TR	2.	SMALL SEED	68.0000	2.0000	0.8211	0.8485	(34)
TR	3.	MIXED SEED	69.0000	2.0909	0.9789	0.5502	(33)
CUL	2.	GLENLEA	178.0000	1.5856	0.7185	0.5178	(111)
TR	1.	LARGE SEED	87.0000	1.5000	0.7280	0.5270	(38)
TR	2.	SMALL SEED	63.0000	1.8579	0.8148	0.5836	(38)
TR	3.	MIXED SEED	68.0000	1.6000	0.8039	0.3847	(35)
CUL	3.	PARK	166.0000	1.8939	0.8797	0.4620	(98)
TR	1.	LARGE SEED	88.0000	1.8687	0.8951	0.3842	(32)
TR	2.	SMALL SEED	60.0000	1.8128	0.8437	0.7118	(31)
TR	3.	MIXED SEED	81.0000	1.7941	0.8818	0.3803	(34)
CUL	4.	TOMODS002	133.0000	2.0781	1.2782	1.6287	(84)
TR	1.	LARGE SEED	81.0000	2.6522	1.4018	1.9644	(23)
TR	2.	SMALL SEED	26.0000	1.5525	0.8639	0.5292	(16)
TR	3.	MIXED SEED	47.0000	1.8900	1.1882	1.3800	(25)
TOTAL CASES =			482				

APPENDIX 13

02/18/82

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FILE: S01 (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE BROKEN DOWN BY	DW1 CUL BY TR	DESCRIPTION CULTIVAR TREATMENT	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			44.3170	0.0819	0.0401	0.0016	(482)
CUL	0.		10.8280	0.1022	0.0422	0.0018	(104)
TR	1.	LARGE SEED	4.9930	0.1189	0.0808	0.0028	(42)
TR	2.	SMALL SEED	3.4830	0.0987	0.0324	0.0010	(34)
TR	3.	MIXED SEED	2.1820	0.0828	0.0272	0.0007	(28)
CUL	1.	PITIC 82	8.3420	0.0890	0.0338	0.0011	(108)
TR	1.	LARGE SEED	3.8770	0.0928	0.0312	0.0010	(38)
TR	2.	SMALL SEED	2.8060	0.0828	0.0288	0.0013	(34)
TR	3.	MIXED SEED	2.8790	0.0903	0.0228	0.0011	(33)
CUL	2.	GLENLEA	10.9970	0.0991	0.0381	0.0018	(111)
TR	1.	LARGE SEED	3.8280	0.1009	0.0442	0.0020	(38)
TR	2.	SMALL SEED	2.8000	0.1000	0.0328	0.0011	(38)
TR	3.	MIXED SEED	3.3690	0.0981	0.0273	0.0014	(35)
CUL	3.	PARK	8.0480	0.0821	0.0384	0.0013	(88)
TR	1.	LARGE SEED	2.5880	0.0784	0.0219	0.0010	(33)
TR	2.	SMALL SEED	2.8240	0.0850	0.0418	0.0018	(31)
TR	3.	MIXED SEED	2.8280	0.0831	0.0328	0.0011	(34)
CUL	4.	70M009002	5.3040	0.0828	0.0808	0.0028	(84)
TR	1.	LARGE SEED	2.2880	0.0888	0.0878	0.0034	(23)
TR	2.	SMALL SEED	0.8710	0.0544	0.0333	0.0011	(18)
TR	3.	MIXED SEED	2.1850	0.0888	0.0488	0.0022	(29)

TOTAL CASES = 482

Appendix 14. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at the jointing stage, in 1979.

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FILE SDL2 (CREATION DATE = 12/30/81)

CRITERION VARIABLE BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS HT1 CUL BY TR CULTIVAR TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3880.8000	8.8244	4.8401	23.4284	(407)
CUL	0.		828.0000	8.8042	4.8884	24.8638	(88)
TR	1.	LARGE SEED	343.8000	8.8077	4.8478	24.4818	(38)
TR	2.	SMALL SEED	277.0000	8.1471	4.3875	19.2504	(34)
TR	3.	MIXED SEED	208.8000	8.8348	5.8816	35.7788	(23)
CUL	1.	PITIC 82	388.8000	7.8827	3.8283	15.4317	(82)
TR	1.	LARGE SEED	228.0000	8.0714	3.8838	15.1814	(28)
TR	2.	SMALL SEED	88.0000	8.1428	3.8185	15.3828	(14)
TR	3.	MIXED SEED	87.8000	8.7800	3.7878	14.3472	(10)
CUL	2.	GLENLEA	887.2000	8.2288	8.2888	27.8512	(84)
TR	1.	LARGE SEED	281.8000	7.8182	4.8822	24.8231	(37)
TR	2.	SMALL SEED	247.4000	8.1830	8.8780	31.1247	(27)
TR	3.	MIXED SEED	338.0000	11.2887	4.8528	23.8471	(30)
CUL	3.	PARK	838.8000	10.8128	4.8288	21.3852	(88)
TR	1.	LARGE SEED	348.0000	12.4842	8.3888	28.0387	(28)
TR	2.	SMALL SEED	284.0000	10.1428	4.2771	18.2837	(28)
TR	3.	MIXED SEED	208.8000	10.1833	3.8888	15.1880	(30)
CUL	4.	70M008002	848.8000	10.7808	4.2237	17.8288	(78)
TR	1.	LARGE SEED	328.8000	11.7428	4.0818	18.4148	(28)
TR	2.	SMALL SEED	181.0000	8.0800	4.0888	18.4711	(20)
TR	3.	MIXED SEED	338.8000	10.8818	4.2788	18.2882	(31)
TOTAL CASES =			407				

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FILE SDL2 (CREATION DATE = 12/30/81)

CRITERION VARIABLE BROKEN DOWN BY		DESCRIPTION OF SUBPOPULATIONS T1 CUL BY TR TILLERS PER PLANT CULTIVAR TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			2241.0000	8.8081	2.0843	4.3442	(407)
CUL	0.		584.0000	8.2800	1.8733	2.8000	(88)
TR	1.	LARGE SEED	208.0000	8.2884	1.3711	1.8788	(38)
TR	2.	SMALL SEED	171.0000	8.0284	1.7835	3.1808	(34)
TR	3.	MIXED SEED	128.0000	8.8882	1.9731	3.8933	(23)
CUL	1.	PITIC 82	281.0000	8.8882	3.2008	10.2488	(82)
TR	1.	LARGE SEED	148.0000	8.2887	3.3978	11.8480	(28)
TR	2.	SMALL SEED	83.0000	8.8428	2.0232	4.0934	(14)
TR	3.	MIXED SEED	50.0000	8.0000	3.8873	15.1111	(10)
CUL	2.	GLENLEA	483.0000	8.1383	1.7888	3.2387	(84)
TR	1.	LARGE SEED	174.0000	4.7027	1.8844	2.7703	(37)
TR	2.	SMALL SEED	188.0000	8.7778	2.1843	4.8410	(27)
TR	3.	MIXED SEED	183.0000	8.1000	1.4704	2.1821	(30)
CUL	3.	PARK	488.0000	8.8880	1.8102	3.2787	(88)
TR	1.	LARGE SEED	184.0000	8.8000	1.8887	2.7778	(28)
TR	2.	SMALL SEED	188.0000	8.8788	2.1882	4.8188	(28)
TR	3.	MIXED SEED	178.0000	8.8887	1.8888	2.4844	(30)
CUL	4.	70M008002	474.0000	8.0000	2.1304	4.5388	(78)
TR	1.	LARGE SEED	178.0000	8.3571	2.0224	4.0888	(28)
TR	2.	SMALL SEED	118.0000	8.8000	1.8187	3.8737	(20)
TR	3.	MIXED SEED	178.0000	8.7878	2.3880	5.5978	(31)
TOTAL CASES =			407				

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FILE BDL2 (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	NUMBER OF						
BROKEN DOWN BY	CUL						
BY	TR						
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			918.0000	2.2508	0.6281	0.3955	(407)
CUL	0.		211.0000	2.1978	0.6287	0.3957	(98)
TR	1.	LARGE SEED	81.0000	2.3333	0.5882	0.3459	(38)
TR	2.	SMALL SEED	70.0000	2.0888	0.5143	0.2645	(34)
TR	3.	MIXED SEED	60.0000	2.1738	0.7188	0.5166	(23)
CUL	1.	PITIC 82	80.0000	1.7308	0.6883	0.4731	(82)
TR	1.	LARGE SEED	81.0000	1.8214	0.7228	0.5225	(28)
TR	2.	SMALL SEED	23.0000	1.8428	0.7449	0.5548	(14)
TR	3.	MIXED SEED	18.0000	1.8000	0.5184	0.2687	(10)
CUL	2.	OLENLEA	293.0000	2.1588	0.8338	0.6947	(84)
TR	1.	LARGE SEED	87.0000	1.8108	0.8078	0.6523	(37)
TR	2.	SMALL SEED	88.0000	2.1882	0.7387	0.5453	(27)
TR	3.	MIXED SEED	77.0000	2.5887	0.8281	0.6860	(30)
CUL	3.	PARK	216.0000	2.4418	0.7812	0.6100	(88)
TR	1.	LARGE SEED	77.0000	2.7800	0.7818	0.6118	(28)
TR	2.	SMALL SEED	89.0000	2.4843	0.8232	0.6785	(28)
TR	3.	MIXED SEED	50.0000	2.1233	0.8713	0.7581	(30)
CUL	4.	70M008002	202.0000	2.8870	0.7837	0.6133	(78)
TR	1.	LARGE SEED	78.0000	2.8788	0.7724	0.5958	(28)
TR	2.	SMALL SEED	80.0000	2.8000	0.7809	0.6098	(28)
TR	3.	MIXED SEED	77.0000	2.4838	0.7890	0.6214	(31)
TOTAL CASES =			407				

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FILE BDL2 (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	NUMBER OF						
BROKEN DOWN BY	CUL						
BY	TR						
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			548.8888	1.3412	0.8458	0.7154	(407)
CUL	0.		133.3000	1.3888	0.4738	0.2248	(98)
TR	1.	LARGE SEED	86.8800	1.4348	0.3838	0.1474	(38)
TR	2.	SMALL SEED	48.8000	1.3878	0.5184	0.2687	(34)
TR	3.	MIXED SEED	30.8800	1.3413	0.5887	0.3466	(23)
CUL	1.	PITIC 82	78.1700	1.4488	0.8380	0.7025	(82)
TR	1.	LARGE SEED	38.2400	1.3857	0.5833	0.3402	(28)
TR	2.	SMALL SEED	20.4200	1.4888	0.3388	0.1133	(14)
TR	3.	MIXED SEED	18.8100	1.8810	0.8287	0.6867	(10)
CUL	2.	OLENLEA	135.8700	1.4433	0.8330	0.6947	(84)
TR	1.	LARGE SEED	80.8800	1.3888	0.5911	0.3498	(37)
TR	2.	SMALL SEED	38.2200	1.4188	0.8483	0.7187	(27)
TR	3.	MIXED SEED	46.8900	1.8830	0.4278	0.1831	(30)
CUL	3.	PARK	88.1400	1.1178	0.4823	0.2328	(88)
TR	1.	LARGE SEED	30.8200	1.1007	0.8224	0.6734	(28)
TR	2.	SMALL SEED	32.1200	1.1471	0.8281	0.6860	(28)
TR	3.	MIXED SEED	32.2000	1.1087	0.4080	0.1664	(30)
CUL	4.	70M008002	108.8800	1.3388	0.8282	0.6860	(78)
TR	1.	LARGE SEED	42.8800	1.8088	0.5380	0.2872	(28)
TR	2.	SMALL SEED	18.1800	0.8878	0.3888	0.1518	(20)
TR	3.	MIXED SEED	44.1800	1.4282	0.8037	0.6460	(31)
TOTAL CASES =			407				

Appendix 15. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at the heading stage, in 1979.

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FILE SDL3 (CREATION DATE = 12/30/81)

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS					
BROKEN DOWN BY		HT1	PLANT HEIGHT CM				
		CUL	CULTIVAR				
		TR	TREATMENT				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			13481.1000	28.4891	12.8408	159.7905	(487)
CUL	0.		2359.5000	25.8467	9.2787	86.0878	(92)
TR	1.	LARGE SEED	884.5000	24.5694	7.8657	61.8165	(38)
TR	2.	SMALL SEED	800.5000	28.0158	8.2984	68.8594	(32)
TR	3.	MIXED SEED	674.5000	28.1042	11.0029	121.0648	(24)
CUL	1.	PITIC 82	1707.8000	18.1034	3.8035	12.2751	(108)
TR	1.	LARGE SEED	534.5000	18.1870	3.0896	9.5488	(33)
TR	2.	SMALL SEED	508.5000	18.4255	3.9788	15.8280	(31)
TR	3.	MIXED SEED	663.8000	18.8000	3.4988	12.2190	(42)
CUL	2.	GLENLEA	3131.0000	31.0000	5.5927	31.2500	(101)
TR	1.	LARGE SEED	1171.0000	31.6486	2.8401	8.0703	(37)
TR	2.	SMALL SEED	1004.0000	33.4897	5.9484	35.3854	(30)
TR	3.	MIXED SEED	956.0000	28.1176	6.4458	41.5463	(34)
CUL	3.	PARK	4889.0000	47.8428	6.8834	47.3814	(88)
TR	1.	LARGE SEED	1888.5000	48.8874	8.8488	34.2100	(38)
TR	2.	SMALL SEED	1383.5000	48.4800	7.7852	60.6095	(30)
TR	3.	MIXED SEED	1617.0000	47.2333	6.5990	43.5471	(30)
CUL	4.	TOMOC0002	1814.0000	26.9000	6.8345	46.7102	(80)
TR	1.	LARGE SEED	789.5000	30.7500	5.3484	28.6050	(28)
TR	2.	SMALL SEED	314.0000	20.8333	8.0647	38.7810	(15)
TR	3.	MIXED SEED	800.5000	26.3421	5.7780	33.3828	(19)
TOTAL CASES =			487				

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FILE SOL3 (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	T1	TILLERS PER PLANT					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	TR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			2387.0000	5.1794	2.1002	4.4107	(457)
CUL	0.		489.0000	5.3182	1.8453	3.4080	(82)
TR	1.	LARGE SEED	205.0000	5.8944	1.8177	3.3040	(38)
TR	2.	SMALL SEED	189.0000	5.2813	1.7841	3.1119	(32)
TR	3.	MIXED SEED	118.0000	4.7817	1.9332	3.7373	(24)
CUL	1.	PITIC 82	810.0000	8.7867	2.8070	8.7884	(108)
TR	1.	LARGE SEED	201.0000	8.0908	2.9184	8.5227	(33)
TR	2.	SMALL SEED	184.0000	4.8877	2.5088	6.2988	(31)
TR	3.	MIXED SEED	255.0000	8.0714	2.3418	5.4828	(42)
CUL	2.	GLENLEA	398.0000	3.8408	1.2478	1.5584	(101)
TR	1.	LARGE SEED	135.0000	3.8488	0.7884	0.6231	(37)
TR	2.	SMALL SEED	138.0000	4.8333	1.1388	1.2920	(30)
TR	3.	MIXED SEED	127.0000	3.7363	1.8630	3.4630	(34)
CUL	3.	PARK	524.0000	5.3488	1.7840	3.2188	(98)
TR	1.	LARGE SEED	213.0000	5.8053	1.4248	2.0282	(38)
TR	2.	SMALL SEED	184.0000	5.4887	2.1813	4.7113	(30)
TR	3.	MIXED SEED	147.0000	4.8000	1.7878	3.1988	(30)
CUL	4.	70M008002	348.0000	5.7887	2.2727	5.1880	(80)
TR	1.	LARGE SEED	188.0000	5.0788	2.3482	5.5138	(28)
TR	2.	SMALL SEED	81.0000	5.4000	2.8873	7.1143	(16)
TR	3.	MIXED SEED	107.0000	5.8318	1.8622	3.4678	(19)
TOTAL CASES =			457				

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FILE SOL3 (CREATION DATE = 12/30/81)

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	DW1	DRY WEIGHT PER PLANT					
BROKEN DOWN BY	CUL	CULTIVAR					
BY	TR	TREATMENT					
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1881.8488	4.0741	1.8788	2.4831	(457)
CUL	0.		370.9800	4.0291	1.8888	2.4618	(82)
TR	1.	LARGE SEED	182.4700	4.2353	1.8781	2.4808	(38)
TR	2.	SMALL SEED	118.8300	3.7188	1.2028	1.4488	(32)
TR	3.	MIXED SEED	89.2800	4.1387	1.8493	3.7588	(24)
CUL	1.	PITIC 82	428.9800	4.0882	1.8784	2.8208	(108)
TR	1.	LARGE SEED	137.8900	4.1884	1.8788	2.8218	(33)
TR	2.	SMALL SEED	125.8500	4.0887	1.7704	3.1343	(31)
TR	3.	MIXED SEED	186.5200	3.8848	1.8488	2.7088	(42)
CUL	2.	GLENLEA	407.7400	4.0370	1.4447	2.0871	(101)
TR	1.	LARGE SEED	142.2700	3.8481	1.0871	1.1178	(37)
TR	2.	SMALL SEED	142.1300	4.7377	1.8214	2.3144	(30)
TR	3.	MIXED SEED	123.3400	3.8278	1.5528	2.4111	(34)
CUL	3.	PARK	393.3400	4.0137	1.4128	1.8983	(98)
TR	1.	LARGE SEED	170.8700	4.4882	1.3277	1.7827	(38)
TR	2.	SMALL SEED	111.7000	3.7233	1.4728	2.1688	(30)
TR	3.	MIXED SEED	110.8700	3.8890	1.3342	1.7838	(30)
CUL	4.	70M008002	280.1300	4.3358	1.8840	3.4744	(80)
TR	1.	LARGE SEED	131.0300	5.0388	1.8894	3.4873	(28)
TR	2.	SMALL SEED	83.8400	3.8893	1.8887	3.4478	(16)
TR	3.	MIXED SEED	75.2600	3.8811	1.6053	2.5771	(19)
TOTAL CASES =			457				

Appendix 16. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at maturity, in 1979.

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P406	P407	P408	P409	P410	P411	P412
	P414	P415	P416	P417	P418	P419	P420	P421	P422	P423	P424	P425
	P426	P427	P428	P429	P430	P431	P432	P433	P434	P435	P436	P437
	P438	P439	P440	P441	P442	P443	P444	P445	P446	P447	P448	P449

CRITERION VARIABLE T1
BROKEN DOWN BY CUL
BY TILLERS PER PLANT
CULTIVAR
TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			2210.0000	4.9775	2.0892	4.3607	(444)
CUL	1	PITIC 82	757.0000	5.4480	2.0887	4.3603	(139)
TR	1	SMALL SEED	271.0000	5.1591	2.0803	4.3295	(44)
TR	2	LARGE SEED	236.0000	5.4884	2.4041	5.7795	(42)
TR	3	MIXED SEED	250.0000	4.8077	1.5723	2.4721	(52)
CUL	2	CLENLEA	405.0000	3.7850	1.4144	2.0005	(107)
TR	1	SMALL SEED	128.0000	3.7089	1.4041	1.9715	(34)
TR	2	LARGE SEED	154.0000	3.8500	1.4587	2.1304	(40)
TR	3	MIXED SEED	123.0000	3.7879	1.4038	1.9845	(33)
CUL	3	PARK	850.0000	5.5556	2.1312	4.5421	(117)
TR	1	SMALL SEED	269.0000	5.8473	2.3557	5.5541	(46)
TR	2	LARGE SEED	135.0000	5.0000	1.7541	3.0769	(27)
TR	3	MIXED SEED	246.0000	5.5909	2.0722	4.2939	(44)
CUL	4	70M009002	398.0000	4.9135	2.1517	4.6299	(81)
TR	1	SMALL SEED	129.0000	5.1600	2.1541	4.6400	(25)
TR	2	LARGE SEED	79.0000	4.3689	1.7197	2.9575	(15)
TR	3	MIXED SEED	190.0000	5.0000	2.3265	5.4595	(38)
TOTAL CASES =	444						

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FILE	SDL4	(CREATION DATE = 12/30/81)		
SUBFILE	P401	P402	P403	
	P414	P415	P501	
	P511	P512	P514	
	P509	P510	P511	

P405	P408	P409	P410	P411	P412
P503	P504	P505	P507	P508	P510
P501	P503	P504	P505	P507	P508
P513	P515				

DESCRIPTION OF SUBPOPULATIONS			
CRITERION VARIABLE	H1	HEADS PER PLANT	
BROKEN DOWN BY	CUL	CULTIVAR	
BY	TR	TREATMENT	

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1984.0000	4.4768	1.8826	3.5442	(443)
CUL	1.	PITIC SEED	724.0000	5.2088	2.1382	4.5721	(139)
TR	1.	SMALL SEED	287.0000	5.8409	2.0109	4.0438	(44)
TR	2.	LARGE SEED	230.0000	5.3488	2.8268	8.9882	(43)
TR	3.	MIXED SEED	237.0000	4.6877	1.5770	2.4868	(52)
CUL	2.	GLENLEA	385.0000	3.5981	1.3368	1.7708	(107)
TR	1.	SMALL SEED	118.0000	3.4708	1.3081	1.7112	(34)
TR	2.	LARGE SEED	150.0000	3.7500	1.3840	1.8333	(40)
TR	3.	MIXED SEED	117.0000	3.6458	1.3484	1.8182	(33)
CUL	3.	PARK	841.0000	4.8238	1.7584	3.0818	(117)
TR	1.	SMALL SEED	228.0000	4.9888	2.0488	4.3528	(48)
TR	2.	LARGE SEED	118.0000	4.2583	1.8312	3.3533	(27)
TR	3.	MIXED SEED	198.0000	4.6000	1.2288	1.5118	(44)
CUL	4.	70MG08002	334.0000	4.1750	1.8822	3.5287	(80)
TR	1.	SMALL SEED	108.0000	4.2400	1.8883	3.7733	(28)
TR	2.	LARGE SEED	71.0000	2.8444	1.3048	1.7028	(18)
TR	3.	MIXED SEED	187.0000	4.2432	1.8788	3.5228	(37)
TOTAL CASES =		444					
MISSING CASES =		1 OR 0.2 PCT.					

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FILE	SDL4	(CREATION DATE = 12/30/81)
SUBFILE	P401	P402 P403
	P414	P501
	P511	P512 P514
	P508	P510 P511

P405	P408	P409	P410	P411	P412
P503	P504	P505	P507	P508	P510
P501	P503	P504	P505	P507	P508
P513	P515				

DESCRIPTION OF SUBPOPULATIONS		
CRITERION VARIABLE	WT1	DRY WEIGHT PER PLANT G
BROKEN DOWN BY	CUL	CULTIVAR
BY	TR	TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			7557.7988	17.0991	7.8141	61.0809	(442)
CUL	1.	PITIC SEED	2800.8994	20.6698	8.9294	79.7235	(128)
TR	1.	SMALL SEED	1039.1998	23.6182	7.8390	61.4484	(44)
TR	2.	LARGE SEED	870.3998	20.2419	9.8885	94.0815	(43)
TR	3.	MIXED SEED	881.2998	19.0835	8.7350	76.3008	(52)
CUL	2.	GLEHLEA	1891.1998	17.6748	8.9142	47.8090	(107)
TR	1.	SMALL SEED	874.8998	18.9088	8.5454	42.8420	(39)
TR	2.	LARGE SEED	738.2998	18.4578	7.3926	84.6512	(40)
TR	3.	MIXED SEED	877.9998	17.6181	8.7938	46.1850	(32)
CUL	3.	PARK	1852.4998	13.6000	5.4544	29.7502	(116)
TR	1.	SMALL SEED	820.8998	13.4935	5.4690	41.8488	(48)
TR	2.	LARGE SEED	327.1000	13.0840	5.3005	28.0988	(25)
TR	3.	MIXED SEED	804.6998	13.7432	4.3858	18.2381	(44)
CUL	4.	70M008002	1213.1998	14.8778	8.7080	44.8987	(81)
TR	1.	SMALL SEED	384.8000	14.8520	8.5522	30.8266	(15)
TR	2.	LARGE SEED	282.0000	14.0000	4.4623	19.8117	(28)
TR	3.	MIXED SEED	546.3998	18.6947	8.1886	87.0824	(38)
TOTAL CASES = 444							
MISSING CASES = 2 OR 0.5 PCT.							

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P511 P512 P513 P514 P515 P516 P517 P518 P519 P520 P521 P522
P609 P610 P611 P612 P613 P614 P615 P616 P617 P618 P619 P620

CRITERION VARIABLE V1 SEED YIELD PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3317.9388	7.5097	3.5082	12.2933	(442)
CUL	1.	PITIC 82	1304.3888	8.3842	3.7872	14.1920	(138)
TR	1.	SMALL SEED	489.3500	10.8870	3.4031	11.8808	(44)
TR	2.	LARGE SEED	399.7500	8.2985	4.4882	19.8878	(43)
TR	3.	MIXED SEED	435.3000	8.3712	3.1323	9.8119	(82)
CUL	2.	GLENLEA	828.4488	7.7428	3.1332	9.8171	(107)
TR	1.	SMALL SEED	293.8500	7.4882	3.0078	9.0474	(34)
TR	2.	LARGE SEED	322.8900	8.0672	3.3804	11.4270	(40)
TR	3.	MIXED SEED	281.9100	7.8338	3.0082	9.0271	(33)
CUL	3.	PARK	838.8500	8.4588	2.3973	5.8042	(117)
TR	1.	SMALL SEED	251.7700	8.4733	2.7728	7.8843	(48)
TR	2.	LARGE SEED	138.4200	8.1287	2.4043	5.7800	(27)
TR	3.	MIXED SEED	348.6700	8.6470	1.8533	3.4718	(44)
CUL	4.	TOMMOOSBOO2	848.4300	8.9188	3.1174	9.7180	(78)
TR	1.	SMALL SEED	192.3500	8.8332	2.8487	8.4808	(28)
TR	2.	LARGE SEED	114.4800	8.3800	1.8528	3.8138	(18)
TR	3.	MIXED SEED	288.8500	7.8817	2.8488	14.7911	(39)

TOTAL CASES = 444
MISSING CASES = 2 OR 0.5 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P511 P512 P513 P514 P515 P516 P517 P518 P519 P520 P521 P522
P609 P610 P611 P612 P613 P614 P615 P616 P617 P618 P619 P620

CRITERION VARIABLE F1 HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			27735.0000	62.4882	10.2334	104.7235	(444)
CUL	1.	PITIC 82	8784.0000	63.2862	7.7877	60.1823	(138)
TR	1.	SMALL SEED	2822.0000	64.1384	8.5187	72.5858	(44)
TR	2.	LARGE SEED	2827.0000	61.0930	8.5741	73.5150	(43)
TR	3.	MIXED SEED	3348.0000	64.3289	8.9433	38.3224	(82)
CUL	2.	GLENLEA	7916.0000	73.8813	8.8391	48.7732	(107)
TR	1.	SMALL SEED	2501.0000	73.5588	8.1478	26.4984	(34)
TR	2.	LARGE SEED	3020.0000	75.8000	7.4827	58.6823	(40)
TR	3.	MIXED SEED	2395.0000	72.5788	7.3910	54.8289	(33)
CUL	3.	PARK	8832.0000	68.3932	8.8488	44.2082	(117)
TR	1.	SMALL SEED	2719.0000	69.1087	8.8105	43.8990	(48)
TR	2.	LARGE SEED	1858.0000	67.8288	8.7148	45.0883	(27)
TR	3.	MIXED SEED	2857.0000	68.1138	8.7280	48.2889	(44)
CUL	4.	TOMMOOSBOO2	4183.0000	61.7654	8.6987	31.3588	(78)
TR	1.	SMALL SEED	1273.0000	60.8200	4.8838	20.8287	(28)
TR	2.	LARGE SEED	802.0000	60.1111	4.7388	22.4578	(18)
TR	3.	MIXED SEED	2018.0000	63.1083	8.3482	40.3129	(39)

TOTAL CASES = 444

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FILE SD4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P406	P407	P408	P409	P410	P411	P412
P414	P415	P801	P802	P803	P804	P805	P806	P807	P808	P809	P810	P811
P811	P812	P814	P815	P801	P802	P803	P804	P805	P806	P807	P808	P809
P809	P810	P811	P812	P813	P815	P816	P817	P818	P819	P820	P821	P822

CRITERION VARIABLE		DESCRIPTION OF SUBPOPULATIONS	
BROKEN DOWN BY		HT1	PLANT HEIGHT CM
BY		CUL	CULTIVAR
		TA	TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			43238.0000	97.4910	12.7777	163.2708	(444)
CUL	1.	PITIC SEED	13083.0000	94.1942	7.9528	63.2446	(138)
TR	1.	SMALL SEED	4197.0000	91.7731	8.7731	76.3225	(44)
TR	2.	LARGE SEED	3978.0000	92.4419	8.8059	77.0000	(43)
TR	3.	MIXED SEED	4861.0000	95.4028	6.5237	42.5592	(52)
CUL	2.	GLEHLEA	11985.0000	111.8218	8.7881	76.8888	(107)
TR	1.	SMALL SEED	3489.0000	94.12	8.8810	78.0000	(34)
TR	2.	LARGE SEED	4504.0000	112.9000	11.1326	123.9388	(39)
TR	3.	MIXED SEED	3898.0000	110.7879	8.2453	67.8848	(40)
CUL	3.	PARK	11830.0000	98.8291	7.1091	50.5395	(117)
TR	1.	SMALL SEED	4878.0000	98.4763	7.1701	51.4108	(48)
TR	2.	LARGE SEED	2702.0000	100.7761	9.1872	84.2281	(27)
TR	3.	MIXED SEED	4402.0000	100.0485	7.1857	51.3667	(44)
CUL	4.	70M009002	8547.0000	80.8272	8.0284	37.0448	(81)
TR	1.	SMALL SEED	3008.0000	80.3200	4.8868	22.8800	(28)
TR	2.	LARGE SEED	1419.0000	79.8867	4.8853	23.8718	(18)
TR	3.	MIXED SEED	3123.0000	82.1942	7.2295	52.2094	(44)

TOTAL CASES = 444

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FILE SOL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P406	P407	P408	P409	P410	P411	P412
	P414	P415	P416	P417	P418	P419	P420	P421	P422	P423	P424	P425
	P411	P412	P413	P414	P415	P416	P417	P418	P419	P420	P421	P422
	P408	P409	P410	P411	P412	P413	P414	P415	P416	P417	P418	P419

DESCRIPTION OF SUBPOPULATIONS		
CRITERION VARIABLE	SP1	SPIKELETS PER HEAD
BROKEN DOWN BY	CUL	CULTIVAR
BY	TR	TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3767.0000	8.4842	1.3728	1.8846	(444)
CUL	1.	PITIC SEED	1207.0000	8.8838	1.2742	1.6237	(138)
TR	1.	SMALL SEED	382.0000	8.5818	0.8590	0.7387	(48)
TR	2.	LARGE SEED	385.0000	8.4884	1.8018	2.2568	(43)
TR	3.	MIXED SEED	460.0000	8.8462	1.3044	1.7014	(52)
CUL	1.	ELLENLEA	920.0000	8.8881	1.4828	2.1108	(107)
TR	1.	SMALL SEED	327.0000	8.7352	1.2824	1.6446	(34)
TR	2.	LARGE SEED	348.0000	8.7800	1.1447	1.3103	(40)
TR	3.	MIXED SEED	277.0000	8.2078	1.6190	2.6212	(33)
CUL	3.	PARK	942.0000	8.0513	1.4072	1.9801	(117)
TR	1.	SMALL SEED	382.0000	7.4813	1.0020	1.0047	(48)
TR	2.	LARGE SEED	218.0000	8.0741	1.8171	3.3020	(27)
TR	3.	MIXED SEED	381.0000	8.2045	1.1118	1.2363	(44)
CUL	4.	70H008002	888.0000	8.8173	1.2808	1.6892	(81)
TR	1.	SMALL SEED	211.0000	8.4400	1.6287	2.3400	(28)
TR	2.	LARGE SEED	181.0000	8.4444	2.2112	1.4873	(18)
TR	3.	MIXED SEED	328.0000	8.5788	1.0813	1.1893	(38)

TOTAL CASES # 444

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FILE SDLA (CREATION DATE = 12/30/81)

SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P501 P502 P503 P504 P505 P506 P507 P508 P509 P510 P511 P512

----- DESCRIPTION OF SUBPOPULATIONS -----

CRITERION VARIABLE HL1 HEADLENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			5138.0000	11.8721	2.8173	8.8503	(444)
CUL	1.	PITYC 82	1947.0000	14.0072	2.0128	4.0507	(138)
TR	1.	SMALL SEED	810.0000	13.8538	1.9982	3.9910	(44)
TR	2.	LARGE SEED	808.0000	14.0898	2.1848	4.7735	(43)
TR	3.	MIXED SEED	732.0000	14.0789	1.9288	3.7198	(52)
CUL	2.	CLENLEA	1278.0000	11.9189	2.3815	5.7193	(107)
TR	1.	SMALL SEED	423.0000	12.4412	2.8537	7.0419	(34)
TR	2.	LARGE SEED	478.0000	11.8780	2.2210	4.9327	(40)
TR	3.	MIXED SEED	377.0000	11.4242	2.2843	5.1289	(33)
CUL	3.	PARK	1108.0000	9.4761	1.2585	1.5788	(117)
TR	1.	SMALL SEED	418.0000	9.1087	1.1988	1.4324	(46)
TR	2.	LARGE SEED	284.0000	9.7778	1.2808	1.6441	(27)
TR	3.	MIXED SEED	426.0000	9.8591	1.2885	1.6788	(44)
CUL	4.	TOMOOROO2	808.0000	9.9783	1.2847	1.6744	(81)
TR	1.	SMALL SEED	243.0000	9.7200	1.8144	3.2923	(28)
TR	2.	LARGE SEED	178.0000	9.8448	1.0888	1.1844	(18)
TR	3.	MIXED SEED	388.0000	10.1879	1.1514	1.3257	(38)
TOTAL CASES =	444						

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FILE SDLA (CREATION DATE = 12/30/81)

SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P501 P502 P503 P504 P505 P506 P507 P508 P509 P510 P511 P512

----- DESCRIPTION OF SUBPOPULATIONS -----

CRITERION VARIABLE K1 NUMBER OF KERNELS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			90080.0000	181.8420	87.0410	7578.1387	(441)
CUL	1.	PITYC 82	32885.0000	238.8827	101.1188	10224.3809	(138)
TR	1.	SMALL SEED	12100.0000	275.0000	94.8886	9022.8372	(44)
TR	2.	LARGE SEED	10098.0000	234.8372	114.4384	13098.1395	(43)
TR	3.	MIXED SEED	10687.0000	205.8182	83.7474	7012.8271	(52)
CUL	2.	CLENLEA	18012.0000	151.0588	80.3109	3837.4083	(107)
TR	1.	SMALL SEED	4878.0000	148.4118	88.8720	3430.8738	(34)
TR	2.	LARGE SEED	8270.0000	155.7800	85.1833	4248.8890	(40)
TR	3.	MIXED SEED	4784.0000	148.8750	87.0307	3282.6000	(33)
CUL	3.	PARK	17872.0000	151.0427	83.0804	3875.2818	(117)
TR	1.	SMALL SEED	7082.0000	153.8783	75.4570	5823.7851	(46)
TR	2.	LARGE SEED	3818.0000	141.2883	84.9076	4212.8858	(27)
TR	3.	MIXED SEED	6774.0000	153.8845	48.2877	2140.8858	(44)
CUL	4.	TOMOOROO2	13481.0000	170.7722	78.2887	5544.8218	(78)
TR	1.	SMALL SEED	4092.0000	183.8880	71.8827	5182.8100	(28)
TR	2.	LARGE SEED	2817.0000	155.8000	48.8848	2488.8788	(18)
TR	3.	MIXED SEED	6582.0000	182.8333	87.1880	7801.4000	(38)
TOTAL CASES =	444						
MISSING CASES =	3 OR	0.7 PCT.					

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FILE SDL4 (CREATION DATE = 12/30/81)
 SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
 P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
 P426 P427 P428 P429 P430 P431 P432 P433 P434 P435 P436 P437

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	BY	DESCRIPTION	WEIGHT PER 1000 KERNELS				
BROKEN DOWN BY	BY	CUL	CUL				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			18048.8261	41.7797	8.4682	41.8378	(432)
CUL	1.	PITIC 82	8454.4389	40.1081	3.3004	10.2427	(138)
TR	1.	SMALL SEED	1728.8080	39.2842	3.8548	14.8581	(44)
TR	2.	LARGE SEED	1628.8052	39.8808	2.7071	7.3288	(41)
TR	3.	MIXED SEED	2098.0147	41.1872	3.8730	7.1448	(51)
CUL	2.	GLENLEA	8287.0878	51.3303	3.3888	11.3470	(103)
TR	1.	SMALL SEED	1882.8573	50.9987	3.7988	14.4187	(32)
TR	2.	LARGE SEED	2018.1378	51.7728	2.8888	7.0588	(38)
TR	3.	MIXED SEED	1888.0928	51.1330	3.7207	13.8440	(31)
CUL	3.	PARK	4131.8778	38.8284	2.7837	7.7490	(118)
TR	1.	SMALL SEED	1822.3880	38.2888	2.8088	8.4878	(48)
TR	2.	LARGE SEED	838.7077	38.0272	2.1187	4.4822	(28)
TR	3.	MIXED SEED	1872.8022	38.8788	2.8938	8.3732	(43)
CUL	4.	70MO08002	3178.4348	40.7107	3.2354	10.4881	(78)
TR	1.	SMALL SEED	1018.9248	40.8770	3.1808	10.1154	(28)
TR	2.	LARGE SEED	738.0580	40.8822	3.3348	11.1187	(18)
TR	3.	MIXED SEED	1422.4810	40.8418	3.2143	10.3844	(38)
TOTAL CASES =	444						
MISSING CASES =	12 OR 2.7 PCT.						

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FILE SDL4 (CREATION DATE = 12/30/81)
 SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
 P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
 P426 P427 P428 P429 P430 P431 P432 P433 P434 P435 P436 P437

DESCRIPTION OF SUBPOPULATIONS							
CRITERION VARIABLE	BY	DESCRIPTION	WEIGHT PER 1000 KERNELS				
BROKEN DOWN BY	BY	CUL	CUL				
VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			187.8181	0.4388	0.0838	0.0029	(431)
CUL	1.	PITIC 82	81.2429	0.4803	0.0522	0.0027	(138)
TR	1.	SMALL SEED	18.9008	0.4823	0.0289	0.0007	(44)
TR	2.	LARGE SEED	18.4417	0.4488	0.0781	0.0081	(41)
TR	3.	MIXED SEED	22.9008	0.4480	0.0430	0.0018	(51)
CUL	2.	GLENLEA	48.4804	0.4371	0.0388	0.0018	(104)
TR	1.	SMALL SEED	14.8414	0.4408	0.0520	0.0027	(32)
TR	2.	LARGE SEED	16.9288	0.4340	0.0234	0.0005	(38)
TR	3.	MIXED SEED	13.8824	0.4373	0.0382	0.0018	(32)
CUL	3.	PARK	48.2338	0.4003	0.0513	0.0028	(113)
TR	1.	SMALL SEED	18.8117	0.4024	0.0509	0.0026	(48)
TR	2.	LARGE SEED	8.0740	0.3782	0.0707	0.0050	(28)
TR	3.	MIXED SEED	17.8441	0.4103	0.0338	0.0011	(43)
CUL	4.	70MO08002	38.8790	0.4800	0.0824	0.0027	(78)
TR	1.	SMALL SEED	11.2298	0.4492	0.0388	0.0018	(28)
TR	2.	LARGE SEED	8.2453	0.4881	0.0388	0.0013	(18)
TR	3.	MIXED SEED	18.4041	0.4887	0.0858	0.0042	(38)
TOTAL CASES =	444						
MISSING CASES =	13 OR 2.9 PCT.						

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P511 P512 P513 P514 P515 P516 P517 P518 P519 P520 P521 P522
P609 P610 P611 P612 P613 P614 P615 P616 P617 P618 P619 P620

DESCRIPTION OF SUBPOPULATIONS
CRITERION VARIABLE KH1
BROKEN DOWN BY CUL NUMBER OF KERNELS PER HEAD
BY TR CULTIVAR
TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			17384.5552	40.2858	8.0975	82.7848	(431)
CUL	1.	PITIC 82	8214.8801	48.8882	8.8348	74.8587	(138)
TR	1.	SMALL SEED	2080.5813	47.5134	8.4028	41.0085	(44)
TR	2.	LARGE SEED	1785.3858	43.7882	10.8603	111.8208	(41)
TR	3.	MIXED SEED	2328.7332	48.8814	8.4220	70.8298	(51)
CUL	2.	GLENLEA	4288.7076	41.8378	7.1147	50.6184	(103)
TR	1.	SMALL SEED	1387.8888	42.3828	7.8809	82.8840	(33)
TR	2.	LARGE SEED	1808.0388	41.2318	8.8988	43.8547	(38)
TR	3.	MIXED SEED	1282.7023	41.3778	8.9378	48.1343	(31)
CUL	3.	PARK	3782.0831	32.8874	8.7059	44.8880	(118)
TR	1.	SMALL SEED	1434.4888	30.8873	8.8188	43.7883	(48)
TR	2.	LARGE SEED	878.8301	33.8012	8.4828	71.8577	(26)
TR	3.	MIXED SEED	1478.7272	34.3880	8.0487	28.4888	(43)
CUL	4.	70M008002	3088.1144	38.8888	7.8108	82.8818	(77)
TR	1.	SMALL SEED	881.8818	38.8877	7.8108	81.0091	(38)
TR	2.	LARGE SEED	727.4208	40.4128	8.3488	88.7184	(18)
TR	3.	MIXED SEED	1378.8818	40.8880	7.8828	81.8818	(34)

TOTAL CASES = 444
MISSING CASES = 13 OR 2.9 PCT.

APPENDIX 18

03/18/82

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P406 P407 P408 P409 P410 P411 P412
P414 P415 P416 P417 P418 P419 P420 P421 P422 P423 P424 P425
P511 P512 P513 P514 P515 P516 P517 P518 P519 P520 P521 P522
P609 P610 P611 P612 P613 P614 P615 P616 P617 P618 P619 P620

DESCRIPTION OF SUBPOPULATIONS
CRITERION VARIABLE EL1
BROKEN DOWN BY CUL EXTRUSION LENGTH CM
BY TR CULTIVAR
TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			10413.0000	23.4827	7.3285	83.7088	(444)
CUL	1.	PITIC 82	2352.0000	18.8209	4.4844	18.8418	(138)
TR	1.	SMALL SEED	728.0000	18.4773	8.2228	38.7304	(44)
TR	2.	LARGE SEED	743.0000	17.2781	3.8881	18.7288	(43)
TR	3.	MIXED SEED	884.0000	17.0000	2.7835	7.6038	(52)
CUL	2.	GLENLEA	2778.0000	38.8348	4.8831	21.0081	(107)
TR	1.	SMALL SEED	882.0000	28.8412	4.2890	18.4813	(34)
TR	2.	LARGE SEED	1008.0000	28.2280	4.8948	24.8481	(40)
TR	3.	MIXED SEED	884.0000	28.7879	4.3284	18.7348	(33)
CUL	3.	PARK	3740.0000	31.8888	3.3808	11.4288	(117)
TR	1.	SMALL SEED	1438.0000	31.2809	3.2278	10.4183	(48)
TR	2.	LARGE SEED	882.0000	32.8887	4.2807	18.1838	(27)
TR	3.	MIXED SEED	1420.0000	32.2727	2.8314	8.0188	(44)
CUL	4.	70M008002	1848.0000	18.0884	3.3324	11.1048	(81)
TR	1.	SMALL SEED	482.0000	18.8800	2.8285	8.3833	(38)
TR	2.	LARGE SEED	338.0000	18.8111	3.5170	12.3883	(18)
TR	3.	MIXED SEED	718.0000	18.8211	3.7184	12.8044	(38)

TOTAL CASES = 444

Appendix 17. Distribution parameters of characters of single plants, measured at different stages of growth, derived from large seeds, small seeds and alternated large and small seeds.

All plants were grown in three row plots in 1979. Plants with missing neighbours are excluded.

Character	Skewness ^{1,2}			Kurtosis ²		
	Large seed	Small seed	Mixed seed	Large seed	Small seed	Mixed seed
3-5 Leaf Stage:						
Ht ₁	-0.78*	-0.85*	-0.38	1.59*	0.92	0.85
L	-0.80*	-0.34	-0.59	2.60**	1.62*	2.18**
T	-0.59	0.03	-0.59	0.91	-0.01	0.81
Wt	0.29	0.07	0.06	1.24	0.39	0.53
Jointing Stage:						
Ht ₂	0.11	0.45	0.12	1.04	-0.21	-0.35
N	-0.00	-0.19	-0.21	0.98	0.58	-0.61
T	0.07	-0.44	-0.10	0.36	0.31	0.02
Wt	0.42	0.18	0.30	1.42*	-0.29	0.08
Heading Stage:						
Ht ₃	-0.23	-0.39	-0.39	1.01	1.29	1.19
T	-0.57	-0.54	-0.10	0.55	0.32	-0.03
Wt	0.19	0.22	0.15	0.05	-0.59	0.52
Maturity:						
Ht ₃	-0.37	-1.22**	-0.49	0.76	2.45**	0.53
T	0.60	0.14	0.39	0.75	0.61	-0.10
Wt	0.33	0.01	0.41	1.02	0.85	0.38
H	0.27	0.18	0.34	0.57	0.64	0.24
FL	0.13	-0.47	-0.12	1.31	0.49	0.24
ExL	0.16	-0.27	-0.06	0.39	3.06**	0.36
HL	0.06	-1.06*	-0.59	1.31	2.91**	0.94
Sp/H	-0.56	-0.59	-0.50	0.85	0.64	0.10
Y/P	0.34	-0.09	0.35	1.15	0.77	0.31
K/P	0.41	-0.06	0.35	1.58*	0.78	0.22
HI	-0.80*	-1.28**	-0.15	1.95**	2.23**	2.38**
Kwt	-0.50	-0.14	-0.51	0.57*	-0.25	0.92
K/H	-0.33	-0.75*	-0.23	1.84**	0.76	1.03

1. Values of skewness and kurtosis are averages of the values of three replicates and four genotypes.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

Appendix 18a. Plot yield and Specific Mixture Efficiency¹ of mixtures grown in 1977.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1345	138	1.05	0.10
Glenlea	1249	154		
Glenlea + Park	1278	64	1.10	0.09
Glenlea + Neepawa	1361	179	1.12	0.06
Glenlea + 70M110001	1277	80	0.98	0.05
Glenlea + 70M009002	1346	27	0.98	0.07
Glenlea + Norquay	1352	150	1.02	0.16
Glenlea + NB 701	1353	110	1.09	0.05
Park	1096	105		
Park + Neepawa	1227	130	1.08	0.06
Park + 70M110001	1275	97	1.05	0.16
Park + 70M009002	1401	56	1.07	0.01
Park + Norquay	1364	8	1.04	0.03
Park + NB 701	1347	145	1.16	0.13
Neepawa	1170	86		
Neepawa + 70M110001	1302	153	1.03	0.14
Neepawa + 70M009002	1344	65	1.00	0.01
Neepawa + Norquay	1239	103	0.96	0.04
Neepawa + NB 701	1302	126	1.08	0.03
70M110001	1358	253		
70M110001 + 70M009002	1498	123	1.05	0.06
70M110001 + Norquay	1482	92	1.07	0.03
70M110001 + NB 701	1303	70	1.03	0.19
70M009002	1514	64		
70M009002 + Norquay	1451	114	0.99	0.06
70M009002 + NB 701	1508	88	1.10	0.05
Norquay	1418	108		
Norquay + NB 701	1421	36	1.07	0.07
NB 701	1240	203		

1. See Section 8.2.

Appendix 18b. Plot yield and Specific Mixture Efficiency of mixtures grown in 1978.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1012	138	1.02	0.07
Pitic 62	966	251		
Pitic 62 + Glenlea	1111	116	1.11	0.07
Pitic 62 + Park	1014	47	1.08	0.11
Pitic 62 + Neepawa	1112	61	1.08	0.13
Pitic 62 + 70M110001	1105	92	1.09	0.08
Pitic 62 + 70M009002	1006	47	1.11	0.05
Pitic 62 + Norquay	912	79	0.92	0.13
Pitic 62 + NB 701	993	229	1.04	0.03
Glenlea	1043	138		
Glenlea + Park	1085	62	1.10	0.09
Glenlea + Neepawa	1087	115	1.02	0.20
Glenlea + 70M110001	1197	27	1.13	0.02
Glenlea + 70M009002	1067	48	1.13	0.10
Glenlea + Norquay	1063	57	1.02	0.02
Glenlea + NB 701	912	160	0.92	0.10
Park	933	57		
Park + Neepawa	1023	77	1.00	0.06
Park + 70M110001	911	40	0.91	0.00
Park + 70M009002	815	84	0.91	0.09
Park + Norquay	992	118	1.00	0.07
Park + NB 701	880	186	0.93	0.10
Neepawa	1112	92		
Neepawa + 70M110001	1007	125	0.92	0.10
Neepawa + 70M009002	1000	92	1.02	0.13
Neepawa + Norquay	1141	103	1.06	0.12
Neepawa + NB 701	1127	105	1.10	0.11
70M110001	1078	113		
70M110001 + 70M009002	873	124	0.92	0.11
70M110001 + Norquay	1054	66	0.99	0.04
70M110001 + NB 701	1050	168	1.03	0.08
70M009002	859	159		
70M009002 + Norquay	873	2	0.92	0.05
70M009002 + NB 701	894	175	0.99	0.16
Norquay	1049	38		
Norquay + NB 701	1106	31	1.12	0.08
NB 701	941	179		

Appendix 18c. Plot yield and Specific Mixture Efficiency of mixtures grown in 1979.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1248	140	1.03	
Pitic 62	1342	80		
Pitic 62 + Glenlea	1436	36	1.09	0.10
Pitic 62 + Park	1313	11	1.11	0.06
Pitic 62 + Neepawa	1339	59	1.10	0.05
Pitic 62 + 70M110001	1379	29	1.05	0.09
Pitic 62 + 70M009002	1511	80	1.14	0.02
Pitic 62 + Norquay	1437	99	1.19	0.13
Pitic 62 + NB 701	1401	123	1.05	0.12
Glenlea	1312	166		
Glenlea + Park	1238	99	1.06	0.03
Glenlea + Neepawa	1199	75	1.00	0.13
Glenlea + 70M110001	1175	81	0.91	0.11
Glenlea + 70M009002	1313	112	1.01	0.14
Glenlea + Norquay	1271	90	1.08	0.20
Glenlea + NB 701	1272	63	0.97	0.08
Park	1033	104		
Park + Neepawa	1002	38	0.94	0.04
Park + 70M110001	1153	34	1.00	0.04
Park + 70M009002	1212	40	1.04	0.01
Park + Norquay	1082	73	1.02	0.03
Park + NB 701	1324	134	1.12	0.08
Neepawa	1102	125		
Neepawa + 70M110001	1122	44	0.94	0.05
Neepawa + 70M009002	1178	36	0.98	0.04
Neepawa + Norquay	1067	58	0.98	0.08
Neepawa + NB 701	1181	30	0.97	0.02
70M110001	1290	130		
70M110001 + 70M009002	1285	67	1.00	0.08
70M110001 + Norquay	1141	22	0.96	0.07
70M110001 + NB 701	1175	167	0.90	0.14
70M009002	1299	43		
70M009002 + Norquay	1301	62	1.10	0.09
70M009002 + NB 701	1307	45	1.00	0.02
Norquay	1082	122		
Norquay + NB 701	1226	80	1.01	0.07
NB 701	1327	73		

Appendix 19. Performance of mixtures in each of the three years, containing specific genotypes, as expressed by the Array mean yield (Array $\bar{Y}$), the Average Mixture Efficiency (AME)^{1,2}, and the General Combining Ability (GCA)².

Year	Genotype	Array $\bar{Y}$	Std. Dev.	AME	GCA
1977	Pitic 62	--	--	--	--
	Glenlea	1317	118	1.04**	-28.0
	Park	1280	134	1.07**	-71.8*
	Neepawa	1278	134	1.04**	-69.4*
	70M110001	1357	152	1.02*	17.3
	70M009002	1438	104	1.03*	100.9*
	Norquay	1391	121	1.03*	51.0*
	NB 701	1354	138	1.07**	-0.0
1978	Pitic 62	1028	142	1.05**	7.6
	Glenlea	1071	119	1.05**	54.3
	Park	957	121	0.99	-52.2
	Neepawa	1076	106	1.02*	65.6*
	70M110001	1035	138	1.00	24.5
	70M009002	924	128	1.00	-86.1*
	Norquay	1024	110	1.01	13.0
	NB 701	988	177	1.02*	-26.6
1979	Pitic 62	1395	92	1.09**	129.4*
	Glenlea	1277	116	1.01	32.1
	Park	1170	137	1.04**	-81.8*
	Neepawa	1149	112	0.99	-91.5*
	70M110001	1215	117	0.97**	-19.6
	70M009002	1301	112	1.03**	49.8*
	Norquay	1201	145	1.04**	-51.8*
	NB 701	1277	119	1.00	33.4

1. See Section 8.2.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$

Appendix 20.

Calculation of the effect of skewness on single plant selection.

Assume a 50:50 mixture of two genotypes G1 and G2. The mean value for a character X of G1 is 0.3589 σ less than the mean of this character for G2. (The value of 0.3589 had to be chosen due to the restricted number of values listed in chi-square tables). Assume further that X has a chi-square distribution with 30 degrees of freedom, and thus a variance of 2×30 , a skewness of 0.516, and a kurtosis of 0.400. If the 0.75% of the population having the highest values for X were selected, the selected fractions would consist of $1/3$ G1 and $2/3$ G2 (Figure 5). The probability of selecting G1 rather than G2 is $P(\text{Error})=0.333$.

If the character, X, had had a standard normal distribution, it can be found, through trial and error, that:

$$P(z > 2.29) = 0.011$$

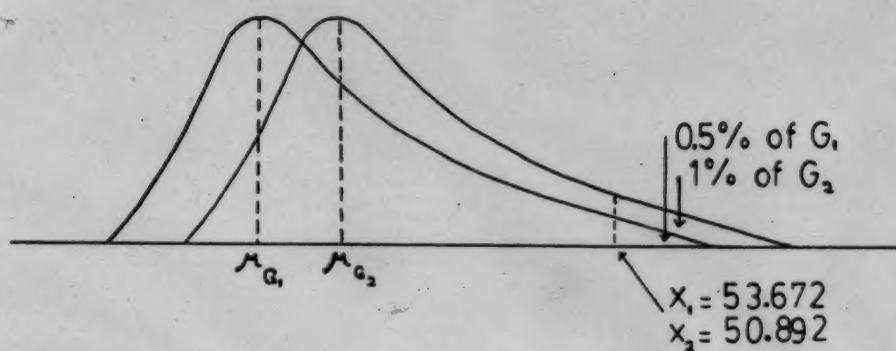
$$P(z > 2.29 + 0.3589) = P(z > 2.6489) = 0.00401$$

$$\text{Total selected fraction} = (0.011 + 0.00401) / 2 = 0.0075$$

The probability to select G1 rather than G2 is

$$P(\text{Error}) = 0.00401 / 0.01501 = 0.267.$$

The probability to select G1 rather than G2 is thus $0.333 / 0.267 = 1.25$ times larger in the case where the distribution of X is skewed, than in the case where the



d.f. = 30

$\sigma^2 = 2 \times 30 = 60$

Skewness = 0.516

Kurtosis = 0.400

$$\mu_{G_1} - \mu_{G_2} = \frac{53.672 - 50.892}{\sqrt{60}} = 0.3589$$

Fig. 5. Graphic illustration of selection in a 50:50 mixture of two genotypes, G_1 and G_2 , for a character x , which has a positively skewed distribution. The selected fraction would, in this case, consist of $1/3 G_1$ and $2/3 G_2$.

distribution of X is normal.

P(Error) will increase, however when the frequency of G2 in the population decreases.

Assume, a mixture of G1 and G2, with means for the character X which are 1.096σ apart, and in which the frequency of G2 is $1/10$ the frequency of G1. The distribution of X is the same as in the previous example. If this time 0.11% of the population is selected, then the probability of selecting G1 rather than G2 is

$$P(\text{Error}) = \frac{10(0.0005)}{0.005 + 10(0.0005)} = \frac{0.005}{0.01} = 0.5$$

If X had had a standard normal distribution, then it can be found, by trial and error, that

$$P(z > 2.41) = 0.008$$

$$P(z > 2.41 + 1.096) = P(z > 3.506) = 0.0002$$

$$P(\text{Error}) = 10(0.0002) / (10 \times 0.0002 + 0.008) = 0.2$$

The probability to select G1 is thus $5/2 = 2.5$ times larger in the case where X is skewed than in the case of a normal distribution of X.

On the other hand, if the distribution of X is negatively skewed, and has a curve which is the mirror image of the curve used in the above examples, the probability to select the superior genotype, G2, is greater than would be the case if X were normally distributed.

For a 50:50 mixture of G1 and G2, with the means 0.151 s apart, it can be calculated, in the same manner as before, that the probability to select G2 is 1.19 times greater than would be the case for a normal distribution, if 0.75 % of the population is selected. If the ratio of G1:G2 is 10:1, and the means are 0.3851 s apart, the probability to select G2 rather than G1 is 1.49 times greater than would be the case if X were normally distributed and 0.11% were selected.